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SUBJECT

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Report of Test on

Preliminary Model CO-2 Transmitters

by

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NAVY DEPARTMENT

BUREAU OF ENGINEERING

Report of Test

on

Preliminary Model GO-2 Transmitters

Manufactured by the

Western Electric Co.

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D.C.

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AUTHORIZATION

1. This problem was authorized by Bureau of Engineering letter, reference (a). Other additional references pertinent to this problem are listed as references (b) to (h).

Reference: (a) BuEng.ltr. NOs-42378(8-9-W3) of 15 August 1935.
(b) Navy Specifications RE 13A 472C.
(c) INM ltr. EN8/c-42378 of 14 May 1936.
(A)
(d) NRL ltr. F42-1/52 of 10 July 1936.
(e) NRL ltr. F42-1/52 of 21 August 1936.
(f) INM ltr. EN8/NOs-35625A, NOs-42378 of 12 October 1936.
(g) NRL ltr. F42-1/52 of 2 December 1936.
(h) NAS report ltr. F42-1/52(NA6)(143), Serial 37Q84 of 19 June 1937.

OBJECT OF TEST

2. These tests were conducted to determine the mechanical and electrical characteristics of the Model GO-2 aircraft patrol plane transmitter as called for by reference (a) in accordance with the governing specifications, reference (b).

ABSTRACT OF TEST

3. The Model GO-2 equipment was tested in the laboratory for compliance with the governing specifications, reference (b). These tests covered the following:

(a) Mechanical, including
(1) Workmanship
(2) Size and weight
(3) Materials
(4) Shock mountings
(5) Controls

(b) Frequency range

(c) Power output

(d) Frequency stability under conditions of
(1) 30-minute keying at 40 words per minute
(2) Variation of ambient temperature
(3) 10% charge of supply voltage
(4) Reset from calibration
(5) Variation of antenna constants

(e) Tests of power supply, including
(1) Input
(2) Rectifier efficiency
(3) Percentage of ripple
(4) Regulation
(5) Compensation

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(f) Observance of character of emission
(1) CW
(2) MCW

(g) Tests of keying action.

(h) General inspection of the equipment to determine suitability for Naval service.

4. The Model GO-2 equipment was transferred to the Naval Air Station, Anacostia, D.C. for flight tests at the conclusion of the laboratory tests.

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CONCLUSIONS

It is concluded that:

(a) The Model GO-2 equipment as originally submitted and resubmitted does not comply with the specifications, reference (b), and is considered unsatisfactory for the Naval service.

(b) With modification of the Model GO-2 equipment, it can be made to conform with the governing specifications in a manner satisfactory to the Bureau of Engineering.

(c) The output circuit as modified is satisfactory and sufficiently flexible for good adjustment at all frequencies into various types of antennas.

(d) The means of reducing power is excellent for continuous variation but at high altitudes and low power, the voltages across the output plate tuning circuit become excessively large, due to controlling the power output with coupling.

(e) The frequency stability is excellent at the intermediate frequencies and good in the high frequency range for normal flight conditions.

(f) Insufficient clearance has been provided for full power high altitude work.

(g) Large letters should be engraved on the tuning knobs in alphabetical order in accordance with the proper sequence for tuning adjustment.

(h) The RK-22, CK-52 and CK-54 rectifier tubes are unsatisfactory.

(i) The power unit is not sufficiently accessible for servicing.

(j) The master oscillator drive mechanism is unsatisfactory.

(k) Some of the controls are too stiff.

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RECOMMENDATIONS

It is recommended that:

(a) The Model GO-2 equipment be modified to correct the defects noted by this Laboratory and the Radio Flight Test Section of the Naval Air Station, Anacostia.

(b) All changes in this equipment or the specification requirements shall be as approved by the Bureau of Engineering.

(c) Additional power reduction be accomplished by lowering the voltage supplied to the rectifier tubes to prevent flash-overs, and corona discharge at high altitudes.

(d) All production Model GO-2 equipments provide as good or better frequency stability than that of the last submitted model.

(e) The insulation and clearances be increased to prevent flash-overs at high altitude full power operation.

(f) Large designating letters be placed on each control knob so that any control can be located at a glance.

(g) Type 38266A rectifier tubes be used in the power supply unit instead of RK-22, CK-52 or CK-54 tubes.

(h) The power unit be made more accessible for servicing or replacement.

(i) A better master oscillator drive mechanism be supplied in both units.

(j) All controls be free and smooth for long periods of time.

(k) The filament voltmeter be marked at the proper operating voltage.

(l) The main and vernier drive shafts be locked at the same time.

(m) Two amperes d.c. be allowed, by specification change, to operate the keying relays.

(n) The power supply plug as furnished with the last model GO-2 be approved and accepted in place of the type called for in Specification 6-1.

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DESCRIPTION OF MATERIAL UNDER TEST

5. The Model GO-2 patrol plane aircraft transmitter was manufactured by the Western Electric Company. As described here this equipment represents repeated redesign and resubmission for tests covering a period of over a year and a half. The frequency range of the low frequency unit is 300 to 600 kilocycles and the high frequency unit covers from 3000 to 13,575 kilocycles. The equipment consists of three units as follows: intermediate frequency, power supply, and high frequency. The two tuning units couple to the power supply unit, one on each side to form one complete assembled unit. CW and MCW are available for all frequencies. Part of the filter is switched out of the circuit for MCW operation.

6. It is possible to operate either transmitter with the other removed. Type 312-A Western Electric pentodes are used as master oscillators and power amplifiers. In the high frequency unit a buffer doubler stage is used between the master and output power amplifier. In the intermediate frequency unit a master oscillator power amplifier circuit is used.

7. The transmitter power supply is furnished by an NEA-1, NEA-1A or NEA-2 generator associated with one 12-volt battery. Two keying relays are used, one on the intermediate frequency unit and one on the high frequency unit. Both relays operate at the same time but only one transmitter can radiate at one time.

METHOD OF TEST

8. The frequency drift was tested by beating the Model GO-2 equipment with the crystal harmonics of the Model LK frequency measuring equipment and visually observing the audio beat frequency difference at room temperature during 1/2-hour key locked, 1/2-hour 40 words per minute keying with an automatic keyer, and continuous key locked signal (equipment installed in a special refrigerator) over a period of time long enough to change temperature slowly from -30° to $+50^{\circ}$C and record temperature and frequency changes. Frequency drift due to 10 per cent variation in supply voltage was also checked with the Model LK equipment. The method of taking frequency variations due to changes in antenna characteristics was by changing the plate current $\pm 25\%$ by antenna adjustment instead of by a 25 per cent change in inductance, capacity, resistance and length of trailing wire.

9. The frequency shift due to poor switch contacts was checked by moving the switch arm slightly and noting the frequency change on the visual indicator. Reset and backlash frequency measurements were made with the Model LK frequency measuring equipment by setting the master oscillator to the desired frequency, detuning the master oscillator, and returning to the original setting by clockwise rotation of the dial, then again by counter clockwise rotation of the dial. Similar reset measurements were made in flight

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and the frequency was received with the Model RAB equipment and checked by the Model LF heterodyne frequency meter.

10. Backlash of the master oscillator as checked by the Model LK is determined by the difference in beat frequency noted when setting to the same dial position from opposite directions.

11. Power output measurements were all made by using an RF ammeter with zircon rods as a load and calculating the power output by formula -

$$W = I^2R$$

where W = Power output in watts
I = Radio frequency current
R = Resistance.

12. Power input measurements were made with a wattmeter ammeter and voltmeter while output measurements were being recorded.

13. Frequency changes due to 10 per cent ($\pm 5\%$) variation of the supply voltage were visually observed with the Model LK frequency measuring equipment. The supply voltage variations were checked by the filament voltmeter at 9.5 volts = -5%
10.0 volts = Normal
10.5 volts = +5%

14. The ripple in the plate supply after rectification and filtration was measured by an Osiso 2 element string oscillograph, associated with the necessary high capacity blocking condenser and high ratio transformer. A 60-cycle timing wave was used. The elements were calibrated for sensitivity at the desired frequencies with an audio oscillator and voltmeter.

15. The plate voltage was measured with a Model 45 Weston direct current voltmeter, Serial No. 40640, at the filter output of the rectifier system after the supply voltage was set to 121 volts and the filament adjusted to 10 volts.

16. A Model 341 Weston alternating current voltmeter, Serial No. 5423, was used to measure the supply voltage.

17. Plate voltage regulation was measured from no load to full load and minimum load to full load voltage by using an external variable load resistor associated with a voltmeter and ammeter.

18. The rectifier power conversion efficiency was calculated by the following formula:

$$\frac{W_1}{W_2 - W_3} \times 100 = \text{percentage}$$

where

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W_1 = Watts, direct current.

W_2 = Watts, alternating current, total full load, key closed.

W_3 = Watts, alternating current, total minimum load, key open.

19. The alternating current input voltage was held constant at 121 volts for all conditions of load.

20. The operation of dials, controls and switches was checked by manipulation at -30°C and +50°C and intermediate points. All structural mechanical details were checked by careful observation.

21. The side tone was checked with a rectifier type of voltmeter.

22. The following instruments were used in addition to the instruments incorporated in the equipment:

(a) Radio Research frequency measuring equipment, Model LK, Serial No. 2.

(b) Naval Research Laboratory heterodyne frequency measuring equipment, Model LF, Serial No. 2.

(c) For radio frequency power measurements, Ward Leonard plaques and zircon rods were used. They were checked for resistance by a type S Leeds and Northrup Wheatstone bridge. In combination with these resistors, two Model 425 Weston thermo-ammeters were used to measure the current, 5 amperes meter Serial No. 22205, 3 amperes meter Serial No. 26117 and Serial No. 28855.

(d) Weston alternating current wattmeter, Model 310, Serial No. 8922.

(e) Weston alternating current, 300 volt voltmeter, Model 341, Serial No. 5017.

(f) Weston alternating current, 150 volt voltmeter, Model 341, Serial No. 8661.

(g) Weston alternating current, 5 and 10 amperes, Model 370, Serial No. 4576.

(h) Weston direct current, 15 amperes, Model 45, Serial No. 33045.

(i) Weston direct current voltmeter, Model 45, Serial No. 40640, and multiplier, Serial No. 40640.

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(j) Weston direct current milliammeter, Model 1, Serial No. 42733, 0.5 amperes shunt for same, Serial No. 42733.

(k) Weston direct current voltmeter, Model 45, Serial No. 15346, 300 and 750 volt ranges, no multiplier.

(l) Weston direct current milliammeter, Model 1, Serial No. 32195, two ranges, 10 and 500 milliamperes. No external shunt required.

(m) Westinghouse Osiso string type oscillograph.

(n) Leeds and Northrup Wheatstone bridge, Type S, Serial No. 220303.

(o) Creed and Company automatic keyer.

(p) Special Naval Research Laboratory refrigerator.

DATA RECORDED DURING TEST

23. The data recorded during these tests are shown in the plates and tables of the Appendix and include the following:

(a) Frequency drifts at 300, 600, 3000, 5500, 8500 and 13,500 kilocycles room temperature.

(b) Frequency drifts at the same frequencies with variation in temperature from -30°C to +50°C.

(c) Frequency resets on the bench and during flight.

(d) Frequency difference due to backlash in master oscillator dial.

(e) Radio frequency power output and input power recorded at the same time.

(f) Frequency variations due to ±5 per cent variation in supply voltages.

(g) Oscillograms showing the percentage of ripple in the power supply.

(h) Oscillograms showing the keying action at 40 words per minute.

(i) Rectifier power conversion and voltage regulation.

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DISCUSSION OF PROBABLE ERRORS

24.

Frequency measurement in flight	.002%
Frequency drift measurements	± 20 cycles
Power output	± 10%
Power input	± 0.5%
Voltage regulation and power conversion	1%

RESULTS OF TESTS

25. No comment will be made on paragraphs that are of a general nature unless serious defects are covered by such paragraphs. Paragraphs that are successfully complied with will be omitted.

1-1. This equipment is intended and suitable for installation in a patrol type of plane in so far as its size and shape is concerned. The weight is excessive. Electrically and mechanically, there are numerous undesirable features which will be reported in detail under the proper specification reference.

1-2. In the intermediate frequency band (300 to 600 kilocycles) excellent communication was possible in flight with a clear note with no form of modulation or frequency variation noticeable.

In the high frequency band (3000 to 13,575 kilocycles) a poor note and bad frequency drift was present on the bench and during flight tests. After this equipment had been modified by adding a buffer doubler stage using the master oscillator from 3000 to 6787 kilocycles, the note was greatly improved.

The relays in the original model were not in synchronism and damage could be caused to the receiving equipment. This condition was corrected in the resubmitted model by putting the power contacts in series. The keying is slowed down to the response of the last relay that closes.

1-3. The equipment as furnished for test consisted of the following:

High frequency transmitter
Intermediate frequency transmitter
Rectifier unit
Complete set of vacuum tubes

1-4. Oscillograms show that the intermediate frequency receiver is disconnected from the antenna, grounded, and the transmitter radiating before the high frequency receiver is disconnected from its antenna and grounded.

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The radiated intermediate frequency may cause damage to the high frequency receiver and in service the cause could not easily be detected without an oscillograph. This has been corrected in the resubmitted model. The second sentence of this specification should be changed to read as follows:

> "When so installed no interference between receivers, one operating in the 300-600 kilocycle band and the other in the 3000 to 13,575 kilocycle band, shall exist and the keying relays shall be mechanically or electrically synchronized so that during the exact transmission time both receivers are disconnected from their antenna and grounded."

1-5. The original Model GO-2 gave contact trouble between the units. To overcome this trouble the unit cases in the resubmitted model were fastened together with numerous screws. The high and intermediate frequency units were easily removed from their cases but the power unit is tied down so tight that it is impossible to quickly and easily remove this unit for replacement or repair.

1-6. The original tubes used as master oscillators and power amplifiers were unsatisfactory (Navy Type 38282A) and they were replaced by a satisfactory pentode (Navy Type 38412). The Raytheon rectifier tubes RK-22, CK-52, and CK-54 are all unsatisfactory and are to be replaced with Navy Type 38266A.

2-4. The master oscillator drive mechanism in all submitted models are unsatisfactory. A proposed design of this control was shown at one of the conferences and if all production models have equally as good drivers, they should be satisfactory.

2-8. The equipment is capable of operating on full power without damage when the antenna is open circuited, short circuited, or grounded. Under certain operating conditions with short antenna at full power and high altitude, difficulty is encountered with flash-overs and corona discharge. This condition also exists at reduced power and sometimes to a greater extent. The radio frequency voltages are higher for reduced power output due to the variable coupling method of power control.

2-11. No equipment is available in this Laboratory for orientation or acceleration test. Actual flight tests as made at the Naval Air Station, Anacostia, do not subject any equipment to the severe requirements of this specification.

2-14. Frequency ranges are not stamped on the interior of the cabinents as called for by this specification.

2-15. The specifications should be changed to combine this paragraph with (2-7). No humidity tests were conducted. The equipment

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was subjected to numerous temperature runs varying from -30°C to +50°C while the pressure and humidity were uncontrolled.

2-16. Some difficulty resulted due to poor grounding contact through the head of a rivet in the relay. This has been corrected.

2-18. The antenna fixed coupling condensers leaked compound at ambient temperatures of +50°C. This condition was corrected in the resubmitted model.

2-19. No test has been made to determine that the shock mounts will stand an acceleration of 8g as called for by 2-11.

2-24. The controls of the resubmitted model are too stiff and hard to operate. The capacity and inductance switches on the master oscillator do not progress numerically with frequency.

2-25. The voltmeter should be marked at the proper operating voltage.

2-29. The fixed condensers associated with the radio frequency output circuit do not comply with this specification. The compound flows at less than +65°C.

2-32. The Raytheon RK-22, CK-52, and CK-54 tubes are unsatisfactory. The manufacturer is changing to 38266A tubes for the rectifier.

2-36. The weight of the original and resubmitted models is excessive (see Table 1 and 1a).

2-37. The single units can be passed through a hatch 18" x 18" but the cases of these are not easily disassembled for this purpose.

2-38. This equipment will withstand one hour locked key and 40 words per minute keying full power into a dummy antenna as described in the power measurement data, Table 2. Under actual operating conditions at high altitudes, corona discharge and sparking occurred at full power and even at reduced power. See reference (h) for detail information. The intermediate frequency and high frequency relays do not operate in synchronism; therefore, the power contacts in the resubmitted model have been connected in series so that both relays must be closed when power is applied. For keying action at 40 words per minute, see Plates 1 and 2.

2-40. Phenolic material should be permitted for use in antenna reels at frequencies above 3000 kilocycles.

2-44. Direct current power of one ampere per relay should be permitted.

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2-45. The equipment was checked for flash-over at the Naval Air Station, Anacostia, in a small cabin plane with much smaller fixed antenna than the one used in patrol planes. The results of these tests are reported in reference (h).

2-46. For power output measurements, see Table 2 and 2a.

3-1. The equipment is capable of satisfactory operation on the antenna systems specified herein, except as noted in reference (h).

(1) The master oscillator power amplifier method is used in this design.

(2) The power output measurements are listed in Tables 2 and 2a.

(3) The size is satisfactory but the units are not easily separated. Access to the power supply is unsatisfactory.

3-4. The intermediate frequency and high frequency unit housing cannot be easily removed from the power unit.

3-5. Access is satisfactory, except the power supply unit, as stated above.

3-6. Snap catches are provided on the tube access door.

3-7. No access doors are used in the side of this equipment.

3-8. The front access door is of the type called for in (3-6).

3-9. The shielding is satisfactory.

3-12. No special switching provision has been made to change types of antenna. It is possible to operate either unit on any one of the three types of antenna called for and connect the other unit to either one of the two remaining. These three types of antenna are never available at the same time. In flight the trailing wire and fixed antenna are available. At anchor the fixed antenna is available and the kite may be flown.

3-13. The break-in relays operate at keying speed. The intermediate frequency unit develops such high voltage at the antenna contacts it is not satisfactory to make and break the antenna direct. The set was modified and now breaks the antenna circuit so that the loading coil is in the antenna lead when the receiver is operating in the intermediate frequency bands. At some frequencies this loading coil reduces the receiver sensitivity.

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This specification should be changed to permit connecting the break in contacts between the loading coil and the transmitter output coupler.

In the last sentence of this specification, simultaneous operation should be required. A time difference of 10 milliseconds in operation of these relays should be specified. Direct current should be permitted for operating these relays. For keying action at 40 words per minute, see Plates 1 and 2.

3-14. Individual side tone volume controls should be required by this specification.

A variable side tone of 800 cycles has been provided in accordance with this paragraph (see Table 3)(for keying action and sidetone, see Plates 1 and 2).

3-16. The equipment has a main power switch, interlock switches, and is properly fused.

3-17. The equipment operates from the power supply described in paragraph 4-1.

3-18. It is desirable to have a continuously variable power output control, but for best operation it should be possible to reduce the voltage supplied to the rectifier by three steps - full, half, and quarter power; in addition to these steps, power could be further varied by changing the antenna coupling. See Tables 4 and 5 for original power control.

3-19. Eliminate this paragraph. It is covered by 4-11.

3-20. For break in operation, see reference (h).

3-21. An inductively coupled antenna circuit should be required. For harmonic radiation, see Table 5.

3-26. Large identifying letters should be engraved on each control knob.

3-27. It is possible to adjust the resubmitted Model GO-2 to any frequency within the required one man minute.

(1) For reset adjustments, see Table 6 and flight test resets, references (e) and (g).

(2) For frequency drift at room temperature, see Table 7. For frequency drift at variable temperatures ranging from -30°C to +50°C, see Table 8. For altitude drift test, see references (e) and (g).

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In the original model momentary variations exceeding 350 cycles were present at 13,575 kilocycles. This was traced to poor switch contacts and it was corrected in the resubmitted model.

3-28. (1) Initial errors in calibration should never exceed 0.02% for the intermediate frequency and 0.01% for the high frequency when using a frequency indicator similar to the Model LM.

(2) For errors due to reset and backlash, see Table 6. For errors in flight, see references (e) and (g).

(3) See Table 8; for altitude flight test, see references (e) and (g).

(4) See Table 9.

(5) See Table 10.

(6) See Table 11.

3-29. The antenna coupling system as originally supplied caused a large percentage of harmonic radiation, and with certain lengths of antenna the best radiation and apparent operating conditions occurred at harmonic frequencies. The resubmitted model employing inductive variable coupling reduces harmonic radiation and it is the most satisfactory. For certain conditions of antenna length and frequency, it is difficult to get power into the antenna and flash-over occurs at times. See reference (h).

3-33. The equipment will operate at full power with antenna open circuited, short circuited, or grounded without permanent injury. Flash-overs occur at high altitudes but do no permanent damage. (See reference (h)).

3-34. The numerical values on the band switches should in all cases increase with frequency.

3-35. All tubes cease to oscillate in key-up position.

3-36. Backlash of the oscillator, as measured by the frequency change and calculated in percentage of the frequency and percentage of the frequency range covered by the condenser, is shown in Table 12.

The master oscillator condenser bearings and the gear drive mechanism has been improved. A model of this drive was shown at one of the conferences and it appeared to be satisfactory for reducing backlash to a minimum.

Electrically, the torque and backlash should not exceed .002% of the operating frequency.

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3-37. The locking device should simultaneously lock the main and vernier controls. This double lock prevents damage to the drive mechanism and gears.

The locking devices supplied on the GO-2 are not on the main drive shaft. They also are of poor construction.

3-38. The frequency range is satisfactory and the equipment can be adjusted to any desired frequency in the range of 300 to 600 kilocycles and 3000 to 13,575 kilocycles.

3-39. A record card for this purpose is attached to the front panel.

3-41. The equipment when adjusted to any frequency in its range on radio test position, then shifted to full power operation, does not maintain that frequency within .02% as specified; at other points it does meet this specification. See Table 13.

3-42. The transmitter frequency can be adjusted in 10 seconds when checking from a calibrated receiver by operating the transmitter in the radio test position while making the check. Table 13 shows the percentage of accuracy expected after such adjustment.

3-43. Sufficient range is covered by the tube adjustment capacity to correct for difference in tube capacities.

4-1. This specification should permit the use of 14 volts, 2 amperes direct current for operating the keying relays in addition to the alternating current that is available.

4-2. The rectifier unit contains all conversion and control equipment required to change the alternating current supply into the required voltage and rectified high voltage direct current, in accordance with paragraph 3-3.

4-3. All necessary cable was supplied to connect to the generator.

4-4. High vacuum rectifier tubes of low internal drop, Type 38266A, should be used instead of the unsatisfactory types, RK-22, CK-52, and CK-54.

4-5. All power output measurements were taken between -30°C and +50°C.

4-6. A suitable rectifier system is supplied.

4-7. The rectifier is so designed that it assures proper operation of the equipment, except the RK-22 tubes. For data on regulation and power conversion, see Table 14. The regulation as specified, no load to full load, is not a possible operating condition; therefore, the regulation has been taken two ways -

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minimum load to full load and no load to full load. For power conversion data, see Table 15.

4-8. Suitable provision has been made to protect personnel from coming in contact with voltages in excess of 25 volts.

4-9. Suitable sidetone provision has been made to insure 6 volts across 600 ohms and proper attenuation to less than .5 volt. Actual measurement shows continuously variable 0 to 7.5 volts across 10 ohms. For original model sidetone, see Table 3.

5-10. The rectifier filter in the high voltage supply is such that the peak to peak voltage ripple is greater than the specified one per cent. The ripple in the low voltage rectifier supply also exceeds one per cent. The percentage of ripple, however, is low enough so that good communication is assured. For data, see Table 16 and Plates 3 and 4.

4-11. A suitable power factor correcting device has been provided on the front panel of the Model GO-2 transmitter.

5-1. For data concerning installation mountings and supports, see reference (h).

6-1. The power supply plug is not in accordance with this specification, but it is a much more convenient and desirable type. The sidetone connections are on the front panel and not associated with the power cable.

7-1. No spare parts were furnished with the preliminary models.

10-1. Preliminary models of the GO-1 and GO-2 equipments have been submitted and resubmitted to the Naval Research Laboratory for test. Satisfactory performance and compliance with the specifications have not been demonstrated to date.

(1) Inspection and test of material, assemblies, sizes, and fit are covered by reference (h).

(2) Alternator power output is recorded in Tables 2, 2a, and 16.

(3) Test of radio frequency power output at various frequencies is recorded in Tables 2, 2a and 16.

(4) The frequency ranges were checked and overlap determined to be less than 5% in the intermediate frequency band and to equal or exceed 5% in the high frequency band. See Table 17.

(5) For frequency stability for conditions of locked key and 40 words per minute, room temperature, $\pm$25% change in I_p by varying the antenna constants, $\pm$5% change in line voltage, full power to minimum power, radio test

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position to full power and change in ambient temperature from -30°C to +50°C. See Tables 7, 8, 9, 10, 11, and 13.

(6) Test for accuracy of reset and backlash, see Table 12 and references (d), (e), and (g).

(7) Test for the character of emission is reported in reference (h).

(8) No special endurance test has been conducted, but the several submitted models have all been subjected to numerous hours of test in the laboratory and air.

(9) For keying action see oscillograms, Plates 1 and 2.

(10) Rectifier power unit measurements are shown in Tables 14, 15, and 16.

(11) Receiver tests under actual operating conditions with the Model GO-2 equipment were conducted in flight and reported in reference (h).

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CONCLUSIONS

26. The Model GO-2 equipment as originally submitted and resubmitted does not comply with the specifications, reference (b), and is considered unsatisfactory for the Naval service.

27. With modification of the Model GO-2 equipment, it can be made to conform with the governing specifications in a manner satisfactory to the Bureau of Engineering.

28. The output circuit as modified is satisfactory and sufficiently flexible for good adjustment at all frequencies into various types of antennas.

29. The means of reducing power is excellent for continuous variation but at high altitudes and low power, the voltages across the output plate tuning circuit become excessively large, due to controlling the power output with coupling.

30. The frequency stability is excellent at the intermediate frequencies and good in the high frequency range for normal flight conditions.

31. Insufficient clearance has been provided for full power high altitude work.

32. Large letters should be engraved on the tuning knobs in alphabetical order in accordance with the proper sequence for tuning adjustment.

33. The RK-22, CK-52, and CK-54 rectifier tubes are unsatisfactory.

34. The power unit is not sufficiently accessible for servicing.

35. The master oscillator drive mechanism is unsatisfactory.

36. Some of the controls are too stiff.

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TABLE 1

Specification (2-36)

Weights of the Original Model

I-F unit with case	45.5 pounds
H-F unit with case	45.8
Rectifier unit with case	37.0
Two partitions	2.2
Ten tubes	1.95
Total weight	132.45
Specified weight	125.00
Overweight	7.45

TABLE 1a

Weights of the Resubmitted Model

I-F unit without case	43.3 pounds
H-F unit without case	53.6
Power unit with I-F and H-F case	66.2
Total	163.1
Specified allowance	125.0
Overweight	38.1

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TABLE 2

Variable Impedance

Direct Coupled Output

Specifications
(2-46)
3-1 (2)

Original Model GO-2
Power Output
CW

Frequency (kc)	300	600	3000	8500	13500
Resistance antenna (ohms)	9.9	9.9	41.3	41.3	41.3
Current antenna	3.83	3.83	2.15	2.2	1.85
Watts antenna	145	145	191	200	141
Watts, a.c.	780	770	800	830	840
Volts, a.c.	126	126	131	128	122
Current, a.c.	6.8	6.7	7	7.5	7
Volt amperes	857	844	917	960	854
Efficiency (per cent)					
a.c. to r.f. watts	18.6	18.8	23.9	24.1	16.8
va to r.f. watts	16.9	17.2	20.8	20.8	16.5

Power Output
MCW

Frequency (kc)	300	600	3000	8500	13500
Resistance antenna (ohms)	9.9	9.9	41.3	41.3	41.3
Current antenna	3.9	4.1	2.2	2.25	2
Watts antenna	150	166	200	209	165
Watts, a.c.	840	850	820	820	720
Volts, a.c.	120	123	123	120	120
Current, a.c.	7.6	7.7	7.3	7.2	6.5
Volt amperes	912	950	898	865	780
Efficiency (per cent)					
a.c. to r.f. watts	17.9	19.5	24.4	25.5	22.9
va to r.f. watts	15.5	17.5	22.3	24.2	21.2

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TABLE 2a

Inductively Coupled Output

Specifications
(2-46)
3-1 (2)

Resubmitted Model GO-2
Power Output
CW

Frequency (kc)	300	600	3000	8500	13500
Resistance antenna (ohms)	8.75	8.75	43.0	43.0	43.0
Current antenna	4.05	4.2	1.75	1.9	1.88
Watts antenna	143	154	136	155	152
Watts, a.c.	725	725	670	660	660
Volts, a.c.	124	123.5	125	124	123.5
Current, a.c.	6.8	6.8	6.1	6.1	6.1
Volt amperes	843	840	763	756	754
Efficiency (per cent)					
a.c. to r.f. watts	19.7	21.2	20.3	23.5	23
va to r.f. watts	17	18.3	17.8	20.5	20.2

TABLE 3

800 Cycle

Sidetone Voltage

Specification
3-14

Load 600 Ohms

Sideton control	0	1	2	3	4	5	6	7	8	9	10
Sidetone voltage	0	1.2	2.6	5	6.5	8	9.5	11.5	13	15	16

	E Minimum	E Maximum
Specified sidetone	0.5 volts	6.0 volts
Measured sidetone	0	16.0

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TABLE 4

Original Model

Specification 3-18 — Power Output Control

I-F Unit Frequency (kc)	R_a 9.9 Ohms Antenna Current Minimum	Maximum	31 W to 125 W Required power variation. C-1 to C-10 Actual power control variation.
300	1.6 a	3.8 a	25 w to 143 w measured power variation.
600	1.8	3.8	32 w to 149 w " " "
H-F Unit	R_a 41.3 Ohms		
3000	0.4 a	1.9 a	7 w to 149 w measured power variation.
4500	0.35	2.0	6 w to 165 w " " "
5500	0.75	2.1	23 w to 182 w " " "
8500	0.75	2.1	23 w to 182 w " " "
13500	0.4	1.95	7 w to 157 w " " "

TABLE 5

Specification 3-21
3-27 (1)
1 man minute

Harmonic Radiation Measured at NKF and NSF Transmitter Located at NKF

Dial Settings: Master Oscillator A	B	C	Power Control D	Power Amplifier E	F	Antenna Coupling G	H	Signal Ratio	4135 kc	8270 kc
3	530	2	10	68	1	1	0	NKF	26 : 1	
								NSF	200 : 1	
3	530	2	5	50	3	9	65	NKF	1 : 13	
								NSF	1 : 2	

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TABLE 6

Frequency Variation

Specification 3-27(1)

Due to Resets Clockwise, Counter-Clockwise, and Backlash.

Original Model

Frequency, kc	300	600	3000	8500	135000
Cycles clockwise, reset	5	5	50	125	100
Percentage	.0016	.0008	.0016	.0015	.0007
Cycles counter-clockwise, reset	10	0	25	150	100
Percentage	.003	0	.0008	.0018	.0007
Cycles backlash	120	205	1150	3500	5750
Percentage	.04	.033	.038	.041	.0425

Resubmitted Model

Frequency, kc	300	600	3000	8000	14000
Cycles clockwise, reset	0	2	50	240	100
Percentage	0	.0003	.0016	.003	.0007
Cycles counter clockwise, reset	0	3	10	480	150
Percentage	0	.0005	.0003	.006	.001
Cycles backlash	50	110	800	1980	6200
Percentage	.0167	.018	.026	.0235	.044

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TABLE 7

Frequency Drift

Full Power 1/2 Hour Locked Key

Room Temperature.

Original Model

Frequency, kc	300	600	3000	8500	13500
Cycles drift	210	210	260	2500	3500
Percentage	.07%	.035	.0087	.029	.026
Temperature, °C.	+23	+24	+26	+25	+22

Resubmitted Model

Frequency, kc	300	600	3000	8000	14000
Cycles drift	190	270	550	1000	2200
Percentage	.063%	.045	.0183	.0125	.0157
Temperature, °C.	+23	+24	+24	+20	+25

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TABLE 8

Frequency Drift

Specification 3-27(2) Full Power Locked Key

(0.05% specified for change of 70°C.)

Original Model

Frequency, kc	300	600	3000	8500	13500
Maximum cycles drift	900	1800	1250	8150	5950
Percentage	.3%	.3	.0417	.096	.044
Start temperature, °C.	-30	-30	-32	-32.5	-31.5
Finish temperature, °C.	+40	+40	+40.8	+39.9	+39

Resubmitted Model

Frequency, kc	300	600	3000	8000	14000
Maximum cycles drift	420	1290	545	1760	2900
Percentage	.14%	.215	.018	.022	.0207
Start temperature, °C.	-30	-28.5	-18	-30	-13
Finish temperature, °C.	+38.5	+40	+50	+42	+50

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TABLE 9

Specification 3-28(4)

Frequency Drift

Full Power $\pm 25\%$ I_p Change

by Varying Antenna Constants.

Original Model

Frequency, kc	300	600	3000	8500	13500
+25% I_p cycles	30	155	100	1500	450
Percentage	.01%	.026	.0033	.0177	.0033
-25% I_p cycles	105	105	90	-	150
Percentage	.035	.0175	.0030	-	.0011

Resubmitted Model

Frequency, kc	300	600	3000	8000	14000
Cycles change for +25% I_p	10	0	40	120	250
Percentage	.003	0	.0013	.0015	.0018
Cycles change for -25% I_p	2	35	90	80	50
Percentage	.0006	.006	.003	.001	.00036

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TABLE 10

Frequency Drift

Due to 10% (±5%) Line Voltage

Specification 3-28(5)

Change.

Original Model

Frequency, kc	300	600	3000	8500	13500
Cycles change	7	10	5	375	450
Percentage	.0023	.0016	.00017	.0044	.0033

Resubmitted Model

Frequency, kc	300	600	3000	8000	14000
Cycles change	10	50	25	200	250
Percentage	.0033	.0083	.00083	.00235	.00185

TABLE 11

Frequency Drift

Specification 3-28(6)

Full Power to Minimum Power

Original Model

Frequency, kc	300	600	3000	8500	13500
Cycles change	120	210	245	250	1750
Percentage	.04	.035	.0082	.0029	.013

Using screen grid power control.

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TABLE 12

Specification 3-36

Backlash

Operating Frequency	Cycles	Operating Freq. Error	Freq. Range of Control	Tuning Range Error
300 kc	120	.04%	24.5 kc	.49%
600	205	.033	46.7	.44
3000	1225	.041	540	.227
4500	1925	.043	400	.48
5500	2900	.053	400	.725
8500	3500	.041	600	.584
13500	5750	.042	900	.64

0.1% = Maximum specified allowance of tuning range.

TABLE 13

Specification 3-41

Frequency Variation from Radio Test to Full Power.

Original Model

Frequency, kc	300	600	3000	8500	13500
Cycles change	160	210	400	1000	6500
Percentage	.053	.035	.013	.012	.048

Resubmitted Model

Frequency, kc	300	600	3000	8000	14000
Cycles change	110	150	25	1200	2300
Percentage	.037	.025	.00087	.015	.016

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TABLE 14

High Voltage

Specification 4-7 Rectifier Regulation

	E_p	I_p
No load	2170 volts	2 mills for voltmeter
Minimum load	1210	88
Maximum load	1175	385

Actual operating conditions minimum to maximum load - 2.9%.
Specified requirement but not a possible operating condition - no load to full load 45.8

Low Voltage

Rectifier Regulation

	E_p	I_p
No load	1200 volts	1 mill voltmeter load
Minimum load	640	220 mills
Full load	612	265

Actual operating conditions minimum to maximum load - 4.38%
Specified condition but not a possible operating condition - no load to full load 49.0

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TABLE 15

Specification 4-7

High Voltage

Rectifier Power Conversion and

Efficiency for Various Conditions.

Frequency	Total Input A.C.	Plate Input A.C.	Rectifier Output D.C.	R.F. Output	Efficiency, Per Cent			
					A.C.Line to R.F. Output	A.C.Rectifier Input to R.F. Output	D.C.Rectifier Output to R.F. Output	A.C.Rectifier Input to D.C. Output
300 kc CW	780 w	590 w	487 w	145 w	18.6	24.0	29.8	82.6
MCW	840	650	493	150	17.9	23.1	30.5	76
600 kc CW	790	580	487	145	18.4	25	29.8	84
MCW	850	640	498	166	19.5	26	33.3	78
3000 kc CW	800	600	460	191	23.9	21.9	41.6	76.7
MCW	820	620	456	200	24.4	32.3	43.9	73.6
8500 kc CW	830	630	475	200	24.1	31.8	42.2	75.4
MCW	820	630	464	209	25.5	33.2	45.1	73.8
13500 kc CW	640	440	387	141	22	32	36.5	88
MCW	720	530	412	165	22.9	31.2	40.1	77.8

TABLE 16

Specification 4-10

Ripple Measurements

(1% Allowed)

	R-M-S Volts	1/2 Peak to Peak Volts	Peak to Peak Volts
Oscillograph calibration 1 mm =	0.405	0.571	1.142

High Voltage

Film	A.C. Deflection	R-M-S Volts	Peak to Peak Volts	1/2 Peak to Peak Volts
2A	11 mm minimum load	4.45	12.55	6.28
	at 1210 v 88 ma d.c.	0.368%	1.036%	0.519%
2B	18 mm maximum load	7.28	20.5	10.3
	at 1175 v 385 ma d.c.	0.416%	1.745%	0.877%

Low Voltage

Film	A.C. Deflection	R-M-S Volts	Peak to Peak Volts	1/2 Peak to Peak Volts
2C	9 mm minimum load	3.64	10.27	5.14
	at 640 v 220 ma d.c.	0.570%	1.605%	.803%
2D	10 mm maximum load	4.05	11.43	5.72
	at 612 v 265 ma d.c.	.662%	1.87%	0.935%

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TABLE 17

I-F Oscillator Frequency Overlap

Specification (5% Specified)
10-2(4)
Data, May 26, 1936.

Switch Position	Tuning Dial	Frequency Range	Frequency Overlap	Percentage
1	0	297.5 kc	2.5 kc	.84
1	1000	324.3		
2	0	318.1	6.2	1.95
2	1000	346.2		
3	0	342.8	3.4	.992
3	1000	374.3		
4	0	371.0	3.3	.89
4	1000	404.2		
5	0	397.0	7.2	1.81
5	1000	433.3		
6	0	429.5	3.8	.885
6	1000	467.8		
7	0	462.6	5.2	1.12
7	1000	504.8		
8	0	495.4	9.4	1.9
8	1000	539.4		
9	0	531.2	8.2	1.54
9	1000	579.8		
10	0	563.6	16.2	2.88
10	1000	615.0	15.0	2.44

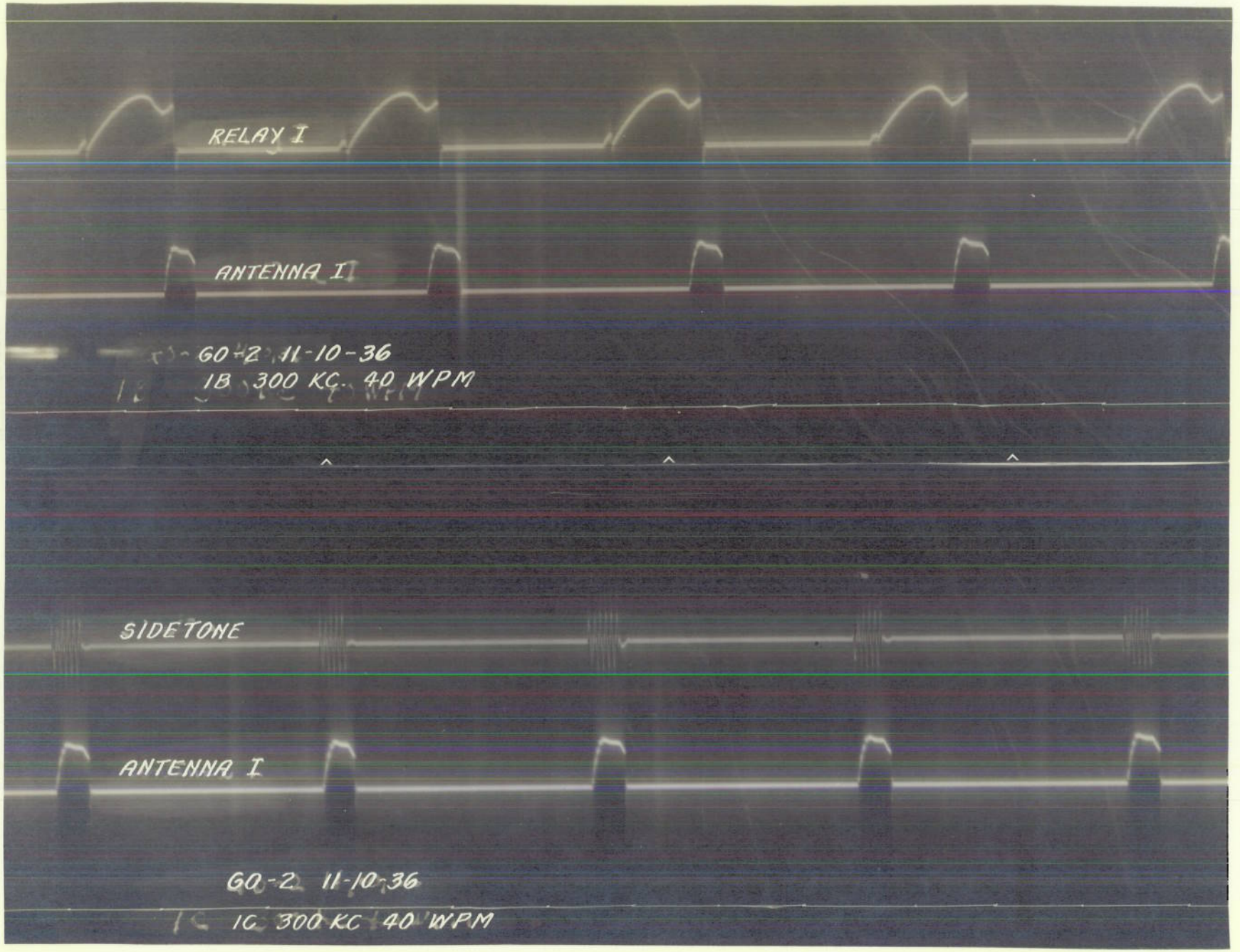
H-F Oscillator Frequency Overlap

Specification
3-34
Data, November 16, 1936

Switch Position	Tuning Dial	Frequency Range	Frequency Overlap	Percentage
1	319	3000 kc		
1	2304	3900	300 kc	7.7
2	74	3600		
2	2276	4700	300	6.4
3	72	4400		
3	2307	5900	400	6.8
4	128	5500		
4	2431	7500	700	9.3
Maximum required		6800		

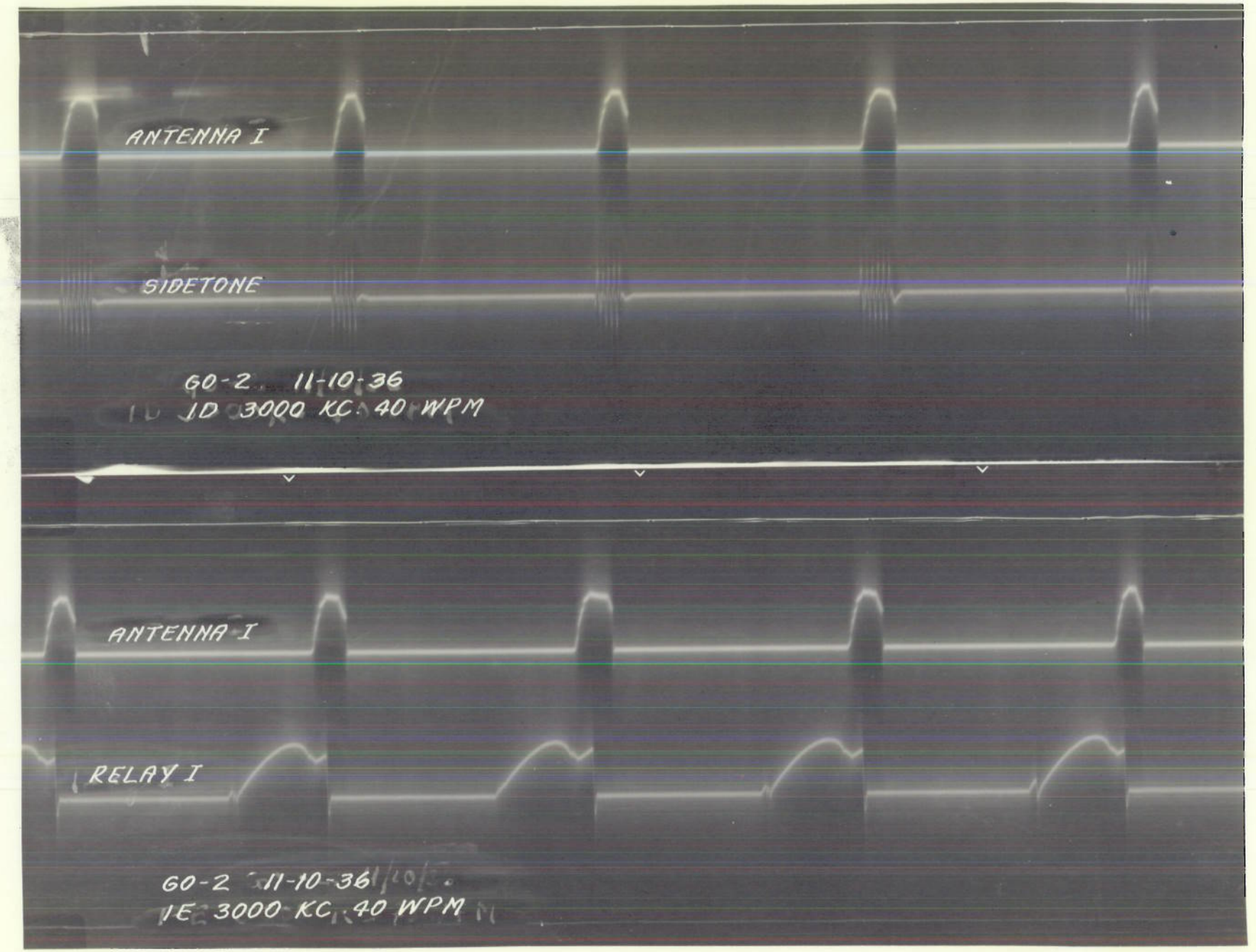
The high frequency overlaps are excessive but conform to the specification which requires more than 5 per cent. The overlap should not be less than 1 per cent or greater than 3 per cent to have more usable divisions on the dial.

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Plate 1



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Plate 2

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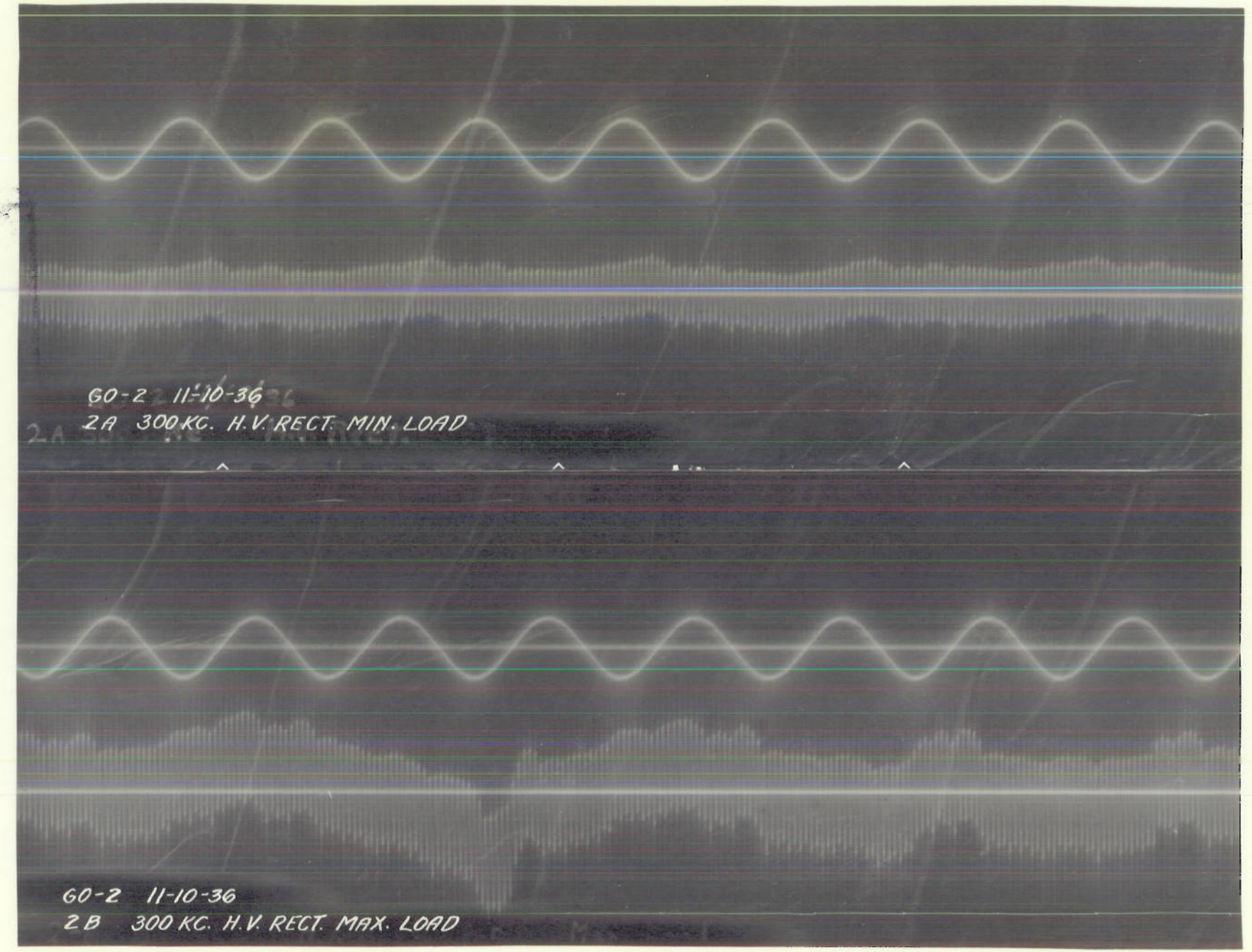
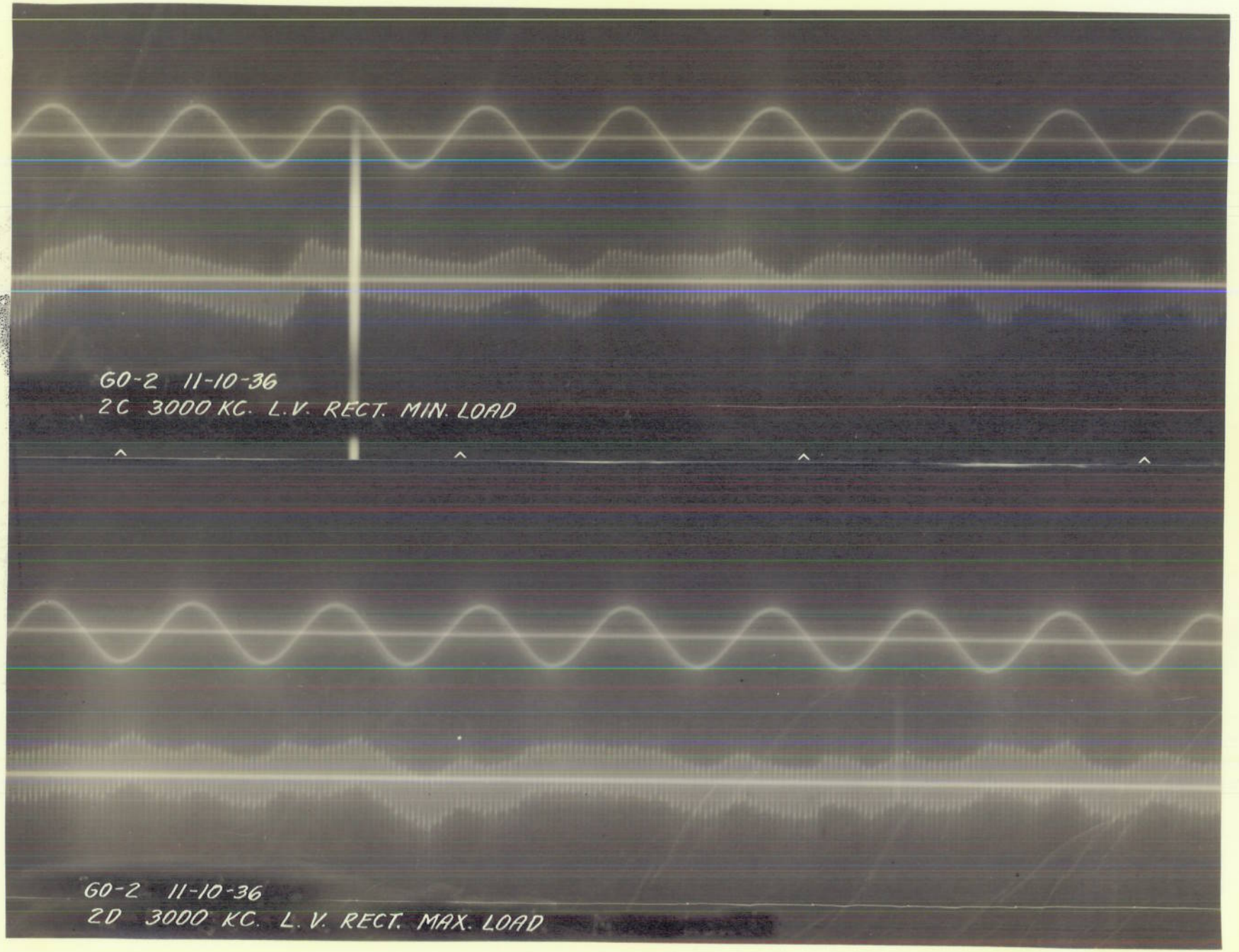


Plate 3



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Plate 4

APPENDIX I

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

F42-1/52 HFH/mbe

10 July 1936

From: Director.
To: Chief of the Bureau of Engineering.

Subject: Preliminary Report of Model GO-2 Aircraft Radio Transmitting Equipment and Recommended Specification Changes.

Reference: (a) BuEng let.NOs-35626(6-20-W3) of 23 June 1936.

Enclosure: (A) Notes on Results of Tests.
(B) Recommended changes in Specification RE 13A 472C.

1. In accordance with reference (a), a preliminary report of the Model GO-2 equipment, manufactured by the Graybar Electric Company, as originally submitted and as modified and resubmitted, is contained in enclosure (A).

2. Proposed specification changes are shown in enclosure (B).

H. M. Cooley

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ENCLOSURE (A)

Notes on Results of Tests

The numbers used at the beginning of the following paragraphs correspond to the paragraph numbers of Specification RE 13A 472C.

1-2, 1-4, 3-13. Oscillograms show that the low frequency receiver is disconnected from the antenna, grounded, and the transmitter radiating before the high frequency receiver is disconnected from its antenna and grounded.

The radiated low radio frequency may cause damage to the high frequency receiver and in service the cause could not easily be detected without an oscillograph.

1-5. The power supply unit cannot be quickly and easily removed from the transmitter cases in the resubmitted model due to the numerous screws.

1-6. Three tubes in the resubmitted high frequency unit had broken filaments or shorted elements.

2-10. At 8500 and 13500 kc in the original model the frequency continually jumped causing a poor note. At 13500 kc the resubmitted model compensation failed and the frequency drift exceeded the specifications. After adjustments were made by the manufacturer's representative a satisfactory run was made at this frequency.

2-24, 3-34. The controls of the resubmitted model are stiff and hard to operate. The capacity and inductance switches on the master oscillator do not progress with frequency.

2-29. The antenna series condensers in the original model high frequency unit leaked compound at +50° C during the temperature frequency test.

2-36. The weight exceeds the specified allowance.

2-37, 3-4. The original model could be easily separated into 3 units by unlatching. These latches did not hold the units tight enough to insure good contact at the terminal blocks.

In the resubmitted model numerous screws are used to hold the cases tight. The holes are elongated and opened up in one position to permit the head to slip through but the cases can not be moved to this position due to the terminal block and the alignment pins. This system is unsatisfactory. Proper catches that hold the units tight and will permit easy removal of the cases for passing through a hatch or repairing the power unit should be provided.

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2-38. The i-f and h-f keying relay receiver break in contacts do not open and close at the same time due to slight lag in the h-f relay and the i-f transmitted radio frequency might damage the h-f receiver. The timing should be the same even if it is necessary to build a h-f - i-f relay with one coil and duplicate contacts.

2-44. The keying relays operate on d.c. in both models. This is not called for in the specification; in fact, complete a-c operation is specified.

2-45, 3-13. The intermediate frequency relay of the original model flashed over at the receiver contacts and terminal insulators, and difficulty at high altitudes is anticipated.

The resubmitted model has this keying relay connected between the loading coil and coupling coil which is contrary to the specification but apparently a necessary compromise.

2-46, 3-1(2). Comparative tables are enclosed to show the relative efficiencies and power outputs with inductively coupled and direct coupled circuits. Power output is satisfactory for both transmitters. (Tables 1 and 1a).

3-12. When the ship is in flight no kite antenna will be available and when the ship is not in flight no trailing will be available. The fixed antenna should be available at all times. The equipment should duplicate operation on kite antenna and trailing wire and it is possible to connect the fixed antenna to either transmitter and use the kite or trailing wire antenna on the other transmitter as desired.

3-14. To permit two operators desiring a different level of side tone in their receiver, individual side tone voltage controls should be used.

3-18, 3-21. The power variation control on the original model was continuously variable by adjusting the screen grid voltage. This control at certain settings permitted easy frequency multiplication or harmonic radiation specially with the type of antenna coupling device supplied.

The resubmitted model employs a variable inductive coupling giving smooth power control with low harmonic radiation. The power amplifier in the high frequency band had a parasitic oscillation at 78 megacycles which was corrected by the manufacturer's representative. The method used for eliminating this undesirable frequency was satisfactory for the model but there is some doubt about its effectiveness in production equipments.

3-27, 3-28. The frequency stability for both models of this equipment does not meet the requirements. See Table 2.

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3-36. The backlash and torque lash is satisfactory in both models. The dials on the resubmitted model are stiff.

3-37. The locking devices used on the dials are not connected direct to the drive shaft as called for and they cause difficulty by dragging on the dial and scratching the etching.

4-1. The relays operate on d.c. which is not in accordance with the specifications. However, d.c. is more satisfactory for this purpose than a.c.

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TABLE 1

Variable Impedance
Direct Coupled Output

Spec.3-1(2)

GO-2 Original Model
Power Output
CW

Frequency (kc)	300	600	3000	8500	13500
Resistance Antenna	9.9 ohms	9.9 ohms	41.3 ohms	41.3 ohms	41.3 ohms
Current Antenna	3.83	3.83	2.15	2.2	1.85
Watts Antenna	145	145	191	200	141
Watts a.c.	780	770	800	830	840
Volts a.c.	126	126	131	128	122
Current a.c.	6.8	6.7	7.0	7.5	7.0
Volt Amperes	857	844	917	960	854
Efficiency					
a.c. to r.f. watts	18.6%	18.8%	23.9%	24.1%	16.8%
va to r.f. watts	16.9%	17.2%	20.8%	20.8%	16.5%

TABLE 1a

Inductively Coupled Output
GO-2 Resubmitted Model
Power Output
CW

Spec.3-1(2)

Frequency (kc)	300	600	3000	8500	13500
Resistance Antenna	8.75	8.75	43.0	43.0	43.0
Current Antenna	4.05	4.2	1.75	1.90	1.88
Watts Antenna	143	154	136	155	152
Watts a.c.	725	725	670	660	660
Volts a.c.	124	123.5	125	124	123.5
Current a.c.	6.8	6.8	6.1	6.1	6.1
Volt amperes	843	840	763	756	754
a.c. to r.f. watts	19.7%	21.2%	20.3%	23.5%	23.0%
va to r.f. watts	17.0%	18.3%	17.8%	20.5%	20.2%

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TABLE 2

Frequency Drift

Full Power 1/2 hr. Key Locked

Spec.(3-27)
(3-28)

Room Temperature

Original Model

Frequency (kc)	300	600	3000	8500	13500
Cycles drift	210	210	260	2500	3500
Percentage	0.07	0.035	0.0087	0.029	0.026

Resubmitted Model

Cycles	190	90	735	1000	2475
Percentage	0.063	0.015	0.024	0.012	0.018

Spec.(3-27)
(3-28)

Frequency Drift for 70°C Change.

Original Model

Frequency (kc)	300	600	3000	8500	13500
Cycles	900	1800	1250	8150	5950
Percent	0.3%	0.3%	0.0417	0.096	0.044
Specified	0.05%	0.05%	0.05%	0.05%	0.05%

Resubmitted Model

Cycles	625	925	1750	5800	3550
Percent	0.208	0.154	0.057	0.068	0.026
Specified	0.05%	0.05%	0.05%	0.05%	0.05%

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ENCLOSURE (B)

Recommended Specification Changes RE 13A 472C

1-4. Second sentence:

When so installed no interference between receivers, one operating in the 300 - 600 kc band and the other in the 3000 - 13575 band, shall exist and the keying relays shall be mechanically or electrically synchronized so that during the exact transmission time both receivers are disconnected from their antennae and grounded.

2-7, 2-15. Combine these paragraphs.

2-38. Add:

When keying at any rate up to 40 w.p.m. the relays shall operate at all times so that both receivers will simultaneously be disconnected from their respective antennae and grounded before the transmission contacts close.

2-44. Change last sentence:

D.C. may be used to operate the keying relays.

3-1(2). Change:

The transmitter unit shall deliver a minimum of 125 watts cw and 125 watts mcw energy, as desired to an optimum length of trailing wire or kite antenna which length must fall within the limits herein specified and at any desired frequency in the frequency range of the particular transmitter. Transmitters must also deliver a minimum of 50 watts into the fixed antenna.

3-4. Change:

The radio frequency units shall not be attached to the power unit with screws and they shall be so designed that either the intermediate or high frequency unit and its housing may be removed easily from the group as installed without interfering in any way with the operation of the remaining units.

3-12. Change third sentence:

It shall be possible to connect either of the transmitter units to the fixed antenna and the other unit to the trailing wire or kite antenna at the same time.

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3-13. Change second sentence:

The antenna break relay for the high frequency unit must operate in such a manner as to transfer the antenna to the receiver directly and not through loading inductor or capacitors. It will be permissible to connect the intermediate frequency relay between the coupling coil and loading coil to prevent r.f. flashover.

Change last sentence:

It is required that both relays operate at the same time when keying either transmitter so that both receivers will be properly disconnected and grounded before the transmitter radiates.

3-14. Add:

An independent continuously variable side tone voltage control shall be provided for each outlet.

3-18. Change:

It must be possible to continuously vary the power output of the transmitter from the maximum value specified to a minimum value not in excess of 25 percent by means of a single adjustment, and it must be possible to thus vary the power while the set is transmitting.

Eliminate last sentence.

3-19. Eliminate: Covered by 4-11.

3-34. Add:

The alphabetical or numerical values on the band switches shall in all cases increase with frequency.

3-36. Add:

Electrically the torque and backlash shall not exceed .002% of the operating frequency.

3-37. Change:

A suitable friction type locking device shall be provided on all tuning controls of the transmitter to prevent accidental movement of the controls. To prevent damage to the gears both main and vernier controls must be locked at the same time.

4-1. Add:

A maximum of two amperes d.c. at 12 volts will be allowed to operate the keying relays.

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APPENDIX II

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

F42-1/52 HFH:LP

21 August 1936

From: Director.
To: The Chief of the Bureau of Engineering.

Subject: Aircraft Radio - Preliminary Model GO-2 Equipment.

Reference: (a) NAS Anacostia let.F42-1/NA6 of 12 Aug.1936.
(b) NRL Preliminary Report let.F42-1/52 of 10 July 1936.

Enclosure: (A) Flight frequency measurements, Tables 1 to 6.

1. At the oral request of the Bureau of Engineering, further comments on the tests of the Model GO-2 equipment are submitted herewith as a supplement to reference (b), and deal with observations made at the Laboratory during flight test operation.

2. The tuning controls are straight forward and very flexible for coupling the transmitters into most any type of antenna except as pointed out by reference (a).

3. Numerous mechanical and electrical details, such as switch contacts, stiff dials, rough beat note at high frequencies, can and should be corrected.

4. The vacuum tubes used in this equipment are very fragile and the elements poorly supported. Four out of nine tubes failed during the tests.

5. The inductance and capacity switch on the h-f oscillator could be ganged and arranged so that the frequency would progress with increasing numbers at all times.

6. The break-in relays are not timed so that protection is provided for both receivers when one relay closes before the other. If the power contacts are put in series, some form of interlock must be provided to close the power circuit in case one transmitter is removed from the assembly. If such an interlock is provided for each transmitter and both transmitters are removed to check the power unit, the primary circuit will be closed by these interlocks.

7. The resets shown for one transmission are poor. See Table 3. This test was repeated and the resets were much better. See Table 6.

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8. The master oscillator temperature compensator is not equally effective with a falling and rising temperature at 13,575 kilocycles. With a decreasing temperature and pressure, the drift was 40 kilocycles and with increasing temperature and pressure it was 1.98 kilocycles. See Table 5. The intermediate frequency transmitter operates in a more normal manner. The frequency drift at 544 kilocycles with decreasing pressure and temperature from 1,000 feet to 16,000 feet is small because the heat around the master oscillator circuit is being radiated at approximately the same rate it is generated. With constant pressure, decreasing temperature and permitting the set to cool at 16,000 feet for 1/2 hour the percentage of drift is high, but with increasing temperature and pressure descending from 16,000 feet to 1,000 feet the frequency returned to a value near the starting frequency. See Table 1.

9. The beat note at 544 kilocycles was excellent at all times. At 8,270 and 13,575 kilocycles the note was very ragged and not considered comparable to other transmitters of similar design previously built.

10. The ragged note in the high frequency transmitter is probably due to numerous causes, high resistance switch contacts, leads vibrating or changing position, non-rigid shields around the master oscillator compartment, high resistance where the frame is riveted together at every joint and too much r-f power output for the size of the tube used in the oscillator. The note was greatly improved at 8,270 kilocycles by using the master oscillator at 4,135 kilocycles instead of 8,270 kilocycles. This type of operation is highly desirable; however, it would require an intermediate amplifier stage to produce the required power output or an electron coupled oscillator with the plate circuit tuned to the radiated frequency.

11. At 8,270 kilocycles the frequency drifted too much between keying periods to insure dependable communication. With a group of transmitters operating on the same frequency, entire transmissions might not be heard unless reset was made to a frequency standard for each transmission. See Tables 2 and 4. The large frequency drift may be due to excessive heating in the master oscillator caused by requiring one oscillator tube to drive the grids of three similar tubes in parallel in the power amplifier stage at the radiated frequency.

12. The Model GO-2 equipment in its present form is not considered satisfactory to effect communication with other units of the Naval Service with precision, reliability, and absence of interference. The faults are of such major importance that complete tests cannot be conducted until a more satisfactory model has been supplied.

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Table 1

Model GO-2 Altitude Flight Test

July 28, 1936

Transmission started at 1445
NSF 544 kcs using NAA
NKF 6600 kcs using GP-3
52-R 544 kcs testing GO-2

Time	Altitude (ft)	Temp. ° C	Frequency kcs
1452	1000	32	543.976
1454	2000	31	-
1456	3000	29	543.959
1459	4000	27	-
1501	5000	26	543.952
1502	6000	25	543.946
1504	7000	24	-
1506	8000	24	543.940
1508	9000	23	-
1510	10000	20	543.946
1513	11000	18	543.952
1515	12000	17	543.959
1517	13000	15	543.964
1519	14000	13	543.964
1522	15000	11	543.964
1525	16000	10	543.964
Shut equipment down open cabin to permit set to cool.			
1555	16000	5	544.375
1556	15000	5	544.358
1558	14000	5	544.334
1600	13000	6	544.322
1601	12000	7	-
1601.5	11000	8	544.298
1602	10000	9	544.286
1603	9000	10	-
1603.5	8000	12	544.262
1604	7000	15	544.250
1605	6000	17	544.238
1605.5	5000	18	544.190
1606	4000	19	544.173
1607	3000	21	544.125
1608	2000	22	544.090
1609	1000	24	544.012

Maximum drift going up = -36 cycles, .0066%
Maximum drift coming down = -363 cycles, .067%
Drift due to cooling equipment one-half hour +411 cycles, .075%

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Table 2

Model GO-2 Altitude Flight Test

July 31,1936

Transmission started at 0935
NKF 6600 using GP-3
52-R 8270 testing GO-2

Time	Altitude (ft.)	Temp. ° C	Frequency kcs
0954	3000	21.2	8283.81
0955	4000	20.0	8283.72
0957	5000	19.0	8284.12
0959	6000	17.8	8284.58
1001	7000	16.2	8285.34
1003	8000	14.4	8287.24
1005	9000	13.3	8284.39
1008	10000	12.2	8286.40
1010	11000	11.1	8285.53
1013	12000	10.5	8286.30
1016	13000	8.9	8286.96
1019	14000	7.2	8286.78
1022	15000	6.1	8287.34
1024	16000	5.6	8287.82
1028	17000	3.3	8289.44
1031	18000	1.1	8289.64
1034	18500	0	8290.40
	Took another reading after communication.		
1037	18500	0	8293.25
	Shut equipment down for 1/2 hour and opened cabin to permit set to cool.		
1103	18500	-4.4	8300.40
1106	17000	-4.4	8299.08
1108	16000	-3.3	8297.85
1111	15000	-2.2	8297.75
1114	14000	- .5	8299.08
1116	13000	+1.1	8298.90
1120	12000	+2.2	8298.60
1122	11000	+3.3	8298.60
1124	10000	+4.4	8298.60
1126	9000	6.1	8298.70
1128	8000	7.2	8298.70
1130	7000	7.8	8298.70
1131	6000	8.3	8298.50
1133	5000	8.9	8298.42
1135	4000	12.2	8298.22
1137	3000	12.8	8298.12
1139	2000	15.5	8297.94
1141	1000	18.3	8297.46

3000 ft. Max. drift going up to 18,500 ft., +6680 cy. or 0.08%
18,500 ft. " " coming down to 1,000 ft. - 2940 cy. or 0.0355%
Drift due to cooling equipment 1/2 hr. at 18,500 ft., 10,000 cy. or 0.121%
18,500 ft. cooling for 3 min.bet.keying periods, 2850 cy., 0.0344%

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Table 3

Model GO-2 Reset, Flight Test

August 3, 1936

Time	Freq.Set	Time	Freq.Reset	Reset Freq. Difference	
955	354.916	1045	354.912	- .004	0.0011%
1003	544.570	1052	544.665	+ .095	0.0175
1015	4136.71	1058	4142.26	+5.55	0.134
1025	8280.0	1105	8294.5	+14.5	0.175
1034	13549.0	1113	13553.0	+4.0	0.0295

A second reset was taken to compare with 1st Reset because the original dial setting at 8280 was uncertain and the apparent drift uncertain.

1105	8294.5	1118	8295.2	+ .7	0.0085

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Table 4

Model GO-2 Altitude Flight Test

August 3, 1936

Transmission started at 1445
NKF 6600 kcs using GP-3
52-R 8270 kcs testing GO-2

Time	Altitude (ft.)	Temp. ° C	Frequency kcs
1450	1000	33.3	8274.85
1456	2000	33.3	8273.71
1459	3000	31.7	8274.85
1502	4000	30.0	8274.66
1505	5000	28.2	8276.09
1508	6000	26.1	8276.57
1512	7000	23.3	8277.04
1515	8000	21.7	8277.04
1518	9000	20.0	8277.52
1523	10000	17.2	8278.38
1526	11000	15.5	8278.57
1529	12000	14.5	8278.76
1531	13000	13.9	8279.14
1533	14000	13.3	8279.33
1538	15000	11.7	8280.00
1542	16000	10.6	8280.00
1548	17000	8.3	8280.09
1552	18000	7.2	8280.68
	Off air for 25 minutes.		
1630	started transmission at 18,000 ft.		
	No altitudes or temperatures were transmitted.		
1631	Descending from 18,000 ft.		8276.84
1632			8277.33
1633			8279.24
1634			8281.15
1635			8283.53
1636			8284.58

Max. drift going up 3000 to 18000 ft. = +6,970 cycles, or 0.084%

Max. drift coming down from 18000 ft. = +7,740 cycles, or 0.0936%

Drift due to 1/2 hour cooling at 18000 ft. = -3740 cycles or 0.0452%

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Table 5

Model GO-2 Altitude Flight Test

NKF - 6600 using GP-3
52-R - 13,575 testing GO-2

Time	Altitude (ft.)	Temp. ^{o} C	Frequency kcs
1013	1000	32.8	13592.99
1015	2000	32.3	13594.62
1017	3000	31.2	13608.1
1020	4000	30.0	13614.1
1024	5000	27.8	13618.7
1027	6000	25.6	13622.3
1030	7000	23.4	13624.49
1034	8000	20.0	13626.25
1037	9000	18.9	13627.22
1041	10000	16.7	13628.16
1044	11000	15.6	13628.04
1047	12000	14.5	13629.25
1050	13000	13.3	13629.8
1053	14000	11.7	13629.66
1056	15000	10.0	13630.2
1100	16000	7.8	13631.3
1103	17000	6.7	13631.98
1106	18000	5.6	13633.06
1115	off until 1140 cooling equipment.		
1140	18000	2.2	13633.96
1142	17000	2.2	13631.98
1144	16000	2.8	13631.3
1145	15000	3.3	13632.38
1146	14000	3.9	13632.78
1148	13000	4.4	13632.38
1150	12000	5.6	13632.38
1152	11000	7.2	13632.38
1155	10000	8.3	13632.92
1156	9000	10.0	13632.92
1158	8000	11.1	13633.05
1200	7000	12.8	13633.2
1202	6000	14.5	13632.52
1204	5000	16.7	13632.52
1206	4000	18.9	13632.35
1207	3000	21.2	13632.25
1210	2000	23.4	13631.98
1212	1000	26.2	13632.78

1000 ft. Max. drift going up to 18,000 ft. +40.07 kcs, 0.295%
18,000 ft. " " coming down to 1000 ft. - 1.98 kcs, 0.0146%
Drift due to cooling at 18,000 ft. for 1/2 hour
+0.90 kcs, 0.0066%

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Table 6

Model GO-2 Reset Flight Test

August 4, 1936

	4135	Freq. Diff.		Time
Frequency Set	4135.22	-	-	1347
1st Frequency Reset	4134.89	-.330	0.008%	1417
2nd Frequency Reset	4135.80	+.580	0.014%	1439
	8270			
Frequency Set	8270.95	-	-	1355
1st Frequency Reset	8270.84	-.110	0.0013%	1423
2nd Frequency Reset	8270.32	-.630	0.0076%	1445
	13575			
Frequency Set	13578.45	-	-	1407
1st Frequency Reset	13577.25	-1.200	0.00885%	1433
2nd Frequency Reset	13579.1	+ .650	0.0048	1449

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APPENDIX III

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D.C.

F42-1/52 HFH/mbe

2 December 1936

From: Director.
To: Chief of the Bureau of Engineering.

Subject: Aircraft Radio - Rebuilt Model GO-2 - Preliminary Report on test of.

Reference: (a) Bueng. ltr. NOs 42378 (8-9-W3-30) of 6 Nov.1936.
(b) N.R.L. ltr. F42-1/52 of 21 August 1936.

Enclosure: (A) Six tables.

1. In accordance with authorization granted by ref. (a), laboratory tests have been conducted to determine the improvement of major defective points noted in the previous model as reported in reference (b).

2. Due to the limited time permitted for these tests, all minor details could not be checked; however, the data taken cover major points and show a great improvement in frequency stability and beat note in the h-f unit, but with a decided increase in weight.

3. The following comments are made as a result of these tests:

(a) The master oscillator drive on the h-f unit is too stiff with excessive back lash and the locking device varies the frequency. This control is too fragile with poor dial visibility causing difficult adjustment in flight and jumpy operation with gloves. The master oscillator switch contacts are greatly improved and apparently caused no frequency changes.

(b) The tubes have been changed in both units to pentodes and they are much more satisfactory. The production model RK-22 tubes are not as satisfactory as the original tubes supplied in the previous model. Occasional arcing in this tube caused slight frequency jumps at times during the tests. All of these tubes should be carefully checked during inspection of the production models.

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(c) The inductance tap switches progress with frequency but due to the doubling feature some confusion might result in setting up on unknown frequencies. It is suggested that the instruction book point out in detail the frequency band covered by each M.O. tap, each buffer amplifier tap and each P.A. tap with simple instructions for setting to any frequency, singling and doubling.

(d) The keying relays have their power contacts connected in series to protect the receiving equipment. The relay appears to be fragile and after several hours of keying at 40 w.p.m. one spring broke, the relay armature worked out of line, the screws worked loose in the bracket that helps support the armature, the rivets that hold the contact block in place worked loose and one antenna break-in contact arm broke.

(e) The results of bench and flight tests for frequency drift and resets are shown in enclosure (A), tables 1 to 6. Flight tests are satisfactory but bench tests on the i-f unit show excessive drift.

(f) The master oscillator temperature compensation has been improved in both i-f and h-f transmitter and better inductances provided in the h-f transmittor.

(g) The i-f unit gives an excellent beat note. The h-f unit beat note is not as good as the i-f unit, but it will give satisfactory telegraphic communications.

(h) The wiring was incomplete and in some cases rather poor.

(i) At all frequencies used during flight tests the stability remained within the specified requirements up to 18,000 feet with temperatures ranging from +8° C to -22° C. During the laboratory refrigerator tests from -30° C to +50° C, the i-f unit exceeded the specified frequency drift.

(j) The weight of the equipment is excessive as shown below:

	I-F Unit	43.3 lbs.
	H-F Unit	53.6 "
Power unit plus I-F & H-F cases		66.2 "
	Total weight	163.1 "
Maximum spec. allowance		125.0 (Spec.2-36)
	Overweight	38.1

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4. The following improvements should be made in the production models:

(a) A more rugged master oscillator drive with locking device that does not vary the frequency, and having less backlash.

(b) Reduction of overall weight with lighter and stronger construction of the bottom and top mounting rig.

(c) The frequency stability of the i-f unit should be improved.

(d) Each control should be better marked. Suggest a large letter on the center of the knob.

(e) The coating on lavite resistors should not flow when the ambient reaches +50° C.

(f) Detail instruction and pictures should be furnished for servicing and adjusting the keying relay.

(g) Better visibility of the master oscillator dial should be provided and figures used that can be read in a poorly lighted cabin.

H. M. Cooley

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TABLE NO. 1

Power Output

Specified 125 Watts

Frequency		AC Watts Input	Antenna Resistance	RF Watts Output
300 kc	CW	770	10 ohms	133
	MCW	790	10 ohms	141
600 kc	CW	710	10 ohms	145
	MCW	710	10 ohms	137
3000 kc	CW	730	41.8 ohms	157
	MCW	820	41.8 ohms	176
8400 kcs	CW	750	41.8 ohms	176
	MCW	790	41.8 ohms	168
13600 kc	CW	690	41.8 ohms	163
	MCW	700	41.8 ohms	157

Satisfactory

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TABLE NO. 2

1/2 hour locked key
Room Temperature

Specified 3-27 (2) .05%

Frequency	Cycles Variation	Percentage
300 kc	+190	.063
600 kc	-270	.045
3000 kc	-550	.018
8000 kc	+1000	.012
14000 kc	-2200	.0157

300 kc drift too much.

TABLE NO. 3

80° Temperature Run

.05% allowed for 70° C.

Specs. (3-27) (3-28)

Temperature range that gives max. drift	Frequency	Cycles	Drift
-30°C to +3° C	300 kc	-420	.14%
-28.5° C to +40° C	600 kc	-1290	.215%
-18° C to +50° C	3000 kc	+545	.018%
-30° C to +40° C	8000 kc	-1760	.022%
-13° C to +50° C	14000 kc	+5800	.0412%

300 and 600 kc drift too much

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TABLE NO. 4

Altitude Flight Test
Frequency Drift
.05% max. allowed

Frequency	Altitude	Temperature	Cycles	Percent
350	5000 to 17500 ft.	-5 to -18° C	-79	.0226
Shut down 15 min.	17500 ft.	-18° C	+53	.0151
	17500 to 1000 ft.	-18° C to -5° C	-35	.01
544	5000 to 17000 ft.	-2 to -17° C	-219	.04
Shut down 15 min.	18600 to 19000 ft.	-20 to -22° C	-5	.001
	19000 to 2000 ft.	-22 to 0° C	-60	.011
4135	3000 to 17000 ft.	+7 to -11° C	-960	.0232
Shut down 15 min.	17000 to 17500 ft.	-11 to -13° C	+840	.0203
	17500 to 1000 ft.	-13 to +8° C	-1160	.028
12405	1000 to 17500 ft.	0 to -18° C	+1150	.0093
Shut down 15 min.	17500 to 19000 ft.	-18 to -20° C	+1260	.0102
	19000 to 1000 ft.	-20 to 0° C	-2560	.0206

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TABLE NO. 5

Resets in Flight

	(350 kc)	Cycles Diff.	
Set Frequency	349.905	-95	.0271%
1st Reset	349.870	-35	.01%
2d Reset	349.840	-65	.0185%
	(544 kc)		
Set Frequency	543.851	-149	.0274%
1st Reset	543.804	-47	.0086%
2d Reset	543.780	-71	.013%
	(4135 kc)		
Set Frequency	4135.850	+850	.0206%
1st Reset	4135.710	-140	.0034%
2d Reset	4136.190	+340	.0092%
	(8268 kc)		
Set Frequency	8268.520	-1480	.018%
1st Reset	8268.710	+190	.0023%
2d Reset	8268.710	+190	.0023%
	(12405 kc)		
Set Frequency	12403.600	-1400	.0113%
1st Reset	12404.620	+1020	.0082%
2d Reset	12406.150	+2550	.0206%

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TABLE NO. 6

Resets in Laboratory

(300 kc)

Set Frequency	300.700	Visual Frequency Indicator	
1st Reset	300.700	Same	
Reverse Reset	300.750	Backlash +50 cycles	.0167%

Dial backlash = 3.5 divisions

(600 kc)

Set Frequency	600.520		
1st Reset	600.518	2 cycles	.0003%
Reverse Reset	600.625	+105 cycles	.0175%

Dial backlash = 4.0 divisions

(3000 kc)

Set Frequency	3000.860		
1st Reset	3000.910	+50 cycles	.00167%
Reverse Reset	3001.660	+800 cycles	.0267%

Dial backlash = 2.5 divisions

(8000 kc)

Set Frequency	8003.440		
1st Reset	3.200	-240 cycles	.003%
Reverse Reset	1.600	-1840 cycles	.0236%

Dial backlash = 2 divisions

(14000 kc)

Set Frequency	13996.750		
1st Reset	13996.650	-100 cycles	.00071
Reverse Reset	14002.950	+6200 cycles	.0443%

Dial backlash = 3 divisions

Suggest that reset should be possible from either direction of dial rotation and remain within .02% of the calibrated frequency.

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APPENDIX IV

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

F42-1/52(NA6)(143)
(Serial 37084)
[redacted] Unclassified June 19, 1937

From: Commanding Officer.
To: Director, Naval Research Laboratory,
Bellevue, Anacostia, D. C.

SUBJECT: Aircraft Radio - Model GO-1 and GO-2 Sample Transmitting Equipments - Report on Flight Tests of.

Reference: (a) N.R.L. ltr. F42-1/52 of 29 March 1935.
(b) BuEng. Specification RE13A 472C, dated 12 December 1934.
(c) BuEng. ltr. NOs-35625(5-7-W3) of 16 May 1935.
(d) BuEng. ltr. NOs-42378(8-9-W3) of 15 August 1935.
(e) NAS Anacostia ltr. F42-1/NA6 of 12 August 1936.
(f) BuEng. ltr. NOs-42378 (9-16-W8) of 17 Sept.1936.
(g) BuEng. ltr. NOs-42378(8-9-W3-30) of 6 Nov.1936.
(h) N.R.L. ltr. F42-1/52 of 10 November 1936.
(i) NAS Anacostia ltr. F42-1(9)/NA6 (303) of 11 November 1936.
(j) BuEng. ltr. NOs-42378(12-11-W3) of 14 Dec.1936.
(k) Memorandum F42-1 (9)/(375) from Lt. Comdr. G. B. H. Hall to Lieut. W.P. Cogswell, dated 31 Dec.1936.
(l) NAS Anacostia ltr. F42-1 (9)/NA6(46) of 26 Feb. 1937.
(m) BuAero. ltr. Aer-E-313-IEH, F42-1/66, of 28 Dec. 1936, to BuEng. and NAS Anacostia.
(n) BuAero ltr. Aer-E-313-VES, F42-1/66 of 14 Jan. 1937, to BuEng. and NAS Anacostia.

Enclosure: (A) Copy of reference (a).
(B) Copy of NAS Anacostia Memorandum Summary on GO-1 Tests, dated 28 April 1935.
(C) Copy of NAS Anacostia Memorandum Summary on GO-2 Tests, dated 17 August, 1936.
(D) Copy of NAS Anacostia Memorandum Summary on GO-2 Tests, dated 6 December, 1936.
(E) Copy of NAS Anacostia Memorandum Summary on GO-2 Tests, dated 7 December, 1936.
(F) Copy of NAS Anacostia Memorandum Summary on GO-2 Tests, dated 8 December,1936.
(G) Copy of reference (k).
(H) Photographic copy of Bell Telephone Laboratories' drawing ESR-605894 dated 9-17-34: Schematic circuit diagram of original Model GO-1 equipment.

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F42-1/52(NA6) (143) GBHH/adl
(Serial 37084)
~~CONFIDENTIAL~~ Unclassified

SUBJECT: Aircraft Radio - Model GO-1 and GO-2 Sample Transmitting Equipments - Report on Flight Tests of.

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Enclosure: (I) Photographic copy of Bell Telephone Laboratories' drawing ESR-607922 dated 5-9-36: Schematic circuit diagram of second preliminary model tested at NAS Anacostia.

(J) Photographic copy of Bell Telephone Laboratories' drawing ESXX-610605 dated 10-26-36: Schematic circuit diagram of final preliminary model tested at NAS Anacostia.

(K) Photographic copy of Bell Telephone Laboratories' drawing ESX-610997 dated 11-6-36: Outline dimensional drawing of final preliminary model tested at NAS Anacostia.

(L) Photographic copy of Bell Telephone Laboratories' drawing ESXX-611159 dated 12-16-36: Schematic circuit diagram proposed for production equipments.

(M) Photograph AN-50053. Final Sample GO-2 radio equipment; front view of complete assembly less cables.

(N) Photograph AN-50054. Final Sample GO-2 radio equipment; upper and lower mounting plates.

(O) Photograph AN-50055. Final Sample GO-2 radio equipment; rear view of rectifier unit.

(P) Photograph AN-50056. Final Sample GO-2 radio equipment; right side view of rectifier unit.

(Q) Photograph AN-50057. Final Sample GO-2 radio equipment; left side view of rectifier unit.

(R) Photograph AN-50058. Final Sample GO-2 radio equipment; right side view of intermediate-frequency unit without case.

(S) Photograph AN-50059. Final Sample GO-2 radio equipment; rear view of intermediate-frequency unit without case.

(T) Photograph AN-50060. Final Sample GO-2 radio equipment; left side view of intermediate-frequency unit without case.

(U) Photograph AN-50061. Final Sample GO-2 radio equipment; right side view of high-frequency unit without case.

(V) Photograph AN-50103. Final Sample GO-2 radio equipment; right rear view of high-frequency unit without P.A. tubes or shield.

(W) Photograph AN-50063. Final Sample GO-2 radio equipment; rear view of high-frequency unit without case.

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F42-1/52 (NA6) (143) Unclassified GBHH/adl
(Serial 37084)
CONFIDENTIAL

Subject: Aircraft Radio - Model GO-1 and GO-2 Sample Transmitting Equipments - Report on Flight Tests of.

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Enclosure: (X) Photograph AN-50064. Final Sample GO-2 radio equipment; left side view of high-frequency unit without case.

(Y) Photograph AN-50065. Final Sample GO-2 radio equipment; top view into M.O. compartment, removed from I.F. unit.

(Z) Photograph AN-50066. Final Sample GO-2 radio equipment; rear view into M.O. compartment, removed from H.F. unit.

(AA) Photograph AN-50067. Final Sample GO-2 radio equipment; left side view into intermediate amplifier compartment, removed from H.F. unit.

(BB) Photograph AN-34384. Second Sample GO-1 radio equipment; detail view of keying relay on I.F. unit, without cover.

(CC) Photograph AN-50068. Final Sample GO-2 radio equipment; detail view of improved keying relay on H.F. unit, without cover.

(DD) Photograph AN-50069. Second Sample GO-1 radio equipment; defective receiver antenna contact arms from keying relays.

(EE) Photograph AN-34762. Three-wire fan type fixed antenna and patrol plane fairlead on XRE-2 airplane for tests of GO-2 equipment.

(FF) Photograph AN-34763. Antenna reel and fairlead mounting in XRE-2 airplane for GO-2 equipment.

(GG) NAS Anacostia Oscillograms 38-C and 40-C showing elimination of keying transient in final sample equipment.

(HH) NAS Anacostia Oscillograms 33-A and 39-A showing elimination of sparking at key contacts.

(JJ) Table of GO-2 Transmitter Test Data, I.F. Unit.

(KK) Table of GO-2 Transmitter Test Data, H.F. Unit.

(LL) Reactance-Resistance Curves for Three-wire fan type Fixed Antenna shown on Enclosure (EE).

(MM) Table of 350 and 8200 kcs reception through GO-2 I.F. transmitter unit.

(NN) Table of 630 kcs reception through GO-2 I.F. transmitter unit.

(OO) Table of 1460 kcs reception through GO-2 I.F. transmitter unit.

(PP) Table of supply voltage compensation data.

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1. This letter reports upon the tests performed at this station in conformity with references (a) and (d), upon preliminary models of the GO-1 and GO-2 equipment. Known in its initial stage as the GO-1, this equipment was later merged with the GO-2 development. The GO-1 and GO-2 production equipments will be identical, except that spare parts and accessories are required only with the model GO-1 equipments.

2. HISTORY OF TESTS. Of four progressive models submitted to the Navy for test, the first, third, and fourth underwent tests at this station as herein reported. In view of obvious defects, the second model was returned by N.R.L. directly to the contractor, without undergoing Navy flight tests. The chronological progress of the tests at this station is summarized as follows:

28 March, 1935: Original model GO-1 received from N.R.L. for flight tests.
28 April, 1935: First series flight tests completed, results summarized in enclosure (B).
29 April, 1935: BuEng. conference, reported by enclosure (A) under reference (c). Equipment returned to contractor for alterations.
19 June, 1936: Received preliminary model GO-2 equipment from N.R.L. for test.
12 August, 1936: Submitted preliminary report, reference (e) to N.R.L.
14 August, 1936: Equipment returned to contractor for further alterations.
17 August, 1936: Memorandum report prepared, enclosure (C); delivered same to BuEng.
27 August, 1936: Conference at Bell Telephone Laboratories, New York City, attended by Navy representatives.
9 Sept. 1936: Second joint conference at Bell Telephone Laboratories, New York City; reported by enclosure (A) under reference (f).
16 November 1936: Received modified preliminary GO-2 equipment from N.R.L. for flight tests.
6 December 1936: Flight tests completed; enclosure (D) prepared.
7 December 1936: Enclosure (E) prepared.
8 December 1936: Enclosure (F) prepared.
9 December 1936: BuEng. conference, reported by enclosure (A) under reference (j).
23 December 1936: Contractor's representative commenced alterations on output tank circuits and keying relay.
31 December 1936: Tests of latest modifications completed reported by enclosure (G).

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6-11 January 1937: Antenna matching tests in laboratory, simulating measured VPB fixed antenna constants.

12-15 January 1937: Contractor's representative made further modifications to equipment by adding inter-unit contacts for M.O. keying circuit; replaced antenna ammeter. Equipment retained at NAS Anacostia for mock-up and test use.

3. FLIGHT TIME. The successive models submitted to this station were flown on 55 flights aggregating 98 hours, distributed as follows:

3-24 April, 1935:	13 flights, totalling 24 hours.
10 July to 14 Aug. 1936:	25 flights, totalling 40 hours.
18 Nov. to 6 Dec. 1936:	17 flights, totalling 34 hours.

4. GO-1/GO-2 EQUIPMENT. The subject equipment is designed for CW and MCW radio telegraph transmission from patrol type airplanes, and incorporates a central rectifier unit, with an intermediate-frequency and a high-frequency transmitter unit attaching to the sides thereof. The final model includes a lower and an upper cushioning supporting frame, with mounting tracks and quick detachable latches.

5. WEIGHTS AND DIMENSIONS. The following weights and dimensions were determined at this station, upon completion of the flight tests with the final model equipment; all weights are inclusive of contained vacuum tubes:

UNIT	WEIGHT lbs.	WEIGHT oz.	DIMENSIONS (OVERALL) INCHES Depth	Width	Height
Rectifier, without sides	35	14	16 9/16	5 7/8	26 15/16
I.F. Transmitter without case	43	5	14 13/16	11	28 3/8
I.F. Transmitter case	10	8	14 3/8	11 1/4	28 7/8
H.F. Transmitter without case	53	8	14 13/16	11	28 3/8
H.F. Transmitter case	10	8	14 3/8	11 1/4	28 7/8
Upper Mounting Plate Assembly	3	11	8 3/16	27 11/16	2 1/4
Lower Mounting Plate Assembly	6	12	14	27 7/8	2 1/4
COMPLETE EQUIPMENT (less cables)	164	5	16 9/16	28 7/16	30 1/2
SIDE TONE CABLES & PLUGS (2)	1	9	Length each 10 ft. 5 inches		
TOTAL WEIGHT, COMPLETE	165	13			

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6. ELECTRICAL CIRCUIT. Enclosures (H), (I), and (J) show the schematic circuit diagrams applying, respectively, to the three progressive models tested at this station. Enclosure (L) is the circuit diagram finally arrived at, which includes all modifications, and which will be followed in the manufacture of the production equipments. These diagrams show the following principal progressive changes:

(a) In its original form (enclosure (H)) the antenna circuit was direct-coupled to the power amplifier. Excessive harmonic radiation and possibility of misadjusting the antenna circuit caused departure from this circuit and subsequent adoption of the inductively coupled antenna circuit shown in enclosures (I), (J), and (L).

(b) Enclosure (J) shows the adoption of a Dow electron-coupled master oscillator in the I.F. unit, the use of separate rectifiers for plate and screen voltage supply, and the progressive use of four separate inductor systems in the M.O. circuit of the H.F. unit. Deficiencies in circuit details are set forth in section C of enclosure (F).

(c) Enclosure (L) shows a revised circuit diagram which includes the additional modifications described in paragraphs 1 and 2 of enclosure (G).

7. TUBES AND SOCKETS. The following vacuum tubes are employed in the final sample model of the equipment:

	Vacuum Tubes	
Purpose	No.	Type
I.F. Master Oscillator	1	CW-38412 (W.E. 312-A)
I.F. Power Amplifier	3	" " " "
H.F. Master Oscillator	1	" " " "
H.F. Int. Amplifier	1	" " " "
H.F. Power Amplifier	3	" " " "
Total	9	CW-38412 (W.E. 312-A)
Plate Voltage Rectifier	2	-38136
Screen Voltage Rectifier	1	-38222

The CW-38412 tube is a transmitting pentode, the -38136 tube a high-vacuum half-wave rectifier, and the -38222 tube a full-wave rectifier of the high-vacuum type. Except for varying, non-standard heights of the 38412 tubes, all tubes in the final model appeared satisfactory and gave suitable performance. The

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spring sleeve type of the retainer, as shown on enclosure (V), was found satisfactory except for inadequacies mentioned under G-16 and H-7 in enclosure (F), and is preferred to the alternate screw type tube clamp shown on enclosures (Z) and (AA).

8. TEST INSTALLATION. In the absence of an actual patrol type of airplane, the subject equipment was tested in the XRE-2 Bellanca cabin type radio test airplane shown in Enclosure (EE). A specially large fixed antenna was provided, with constants (measured by Q-meter) as shown on enclosure (LL). Enclosure (FF) shows, in addition to the observation plant type fairlead, the specially mounted patrol plane "standpipe" type employed for the final tests. The flight test installation further comprised the following auxiliary equipment:

NEA-2 generator.
LM crystal frequency indicator.
Two RU-4 receiving equipments.
NAF antenna reel.

9. TEST OBJECTS. Examinations and tests were performed on the subject equipment to determine the following characteristics:

(a) Installation facility.
(b) Accessibility.
(c) Operating facility.
(d) Output into fixed antenna.
(e) Trailing antenna operation.
(f) Transmission line operation.
(g) Output coupling.
(h) Harmonic radiation.
(i) Signal quality.
(j) Operation with frequency meter.
(k) Frequency re-setability.
(l) Altitude frequency drift.
(m) Break-in operation.
(n) Keying relay suitability.
(o) Effect on receiver trimming and sensitivity.
(p) Electrical failures (at altitude, etc.)
(q) Voltage compensation.
(r) Mechanical ruggedness.

10. INSTALLATION FACILITY AND MOUNTINGS. The installation facility of the final sample equipment was found satisfactory except for deficiencies in the mountings set forth in section F of enclosure (F), and shown in part on enclosures (M) and (N). The

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shock-proof qualities of the mounting were found satisfactory under all flight and taxiing conditions encountered. Enclosure (N) shows the mounting plates.

11. ACCESSIBILITY. The general accessibility for installation and servicing appears relatively satisfactory, with the following exceptions:

(a) The shield surrounding the lower portion of the three P.A. tubes in the H.F. unit (shown on enclosures (U) and (W)) is not readily removed unless the upper portion of the triangular right rear frame gusset is cut away, as shown on enclosure (V). Easy removal of this shield is considered necessary in the production equipments.

(b) Removal and re-insertion of the intermediate-frequency M.O. unit and of the high-frequency M.O.-I.A. unit is a complex and delicate operation; the number of loseable parts should be reduced to a minimum, the marking of the wiring terminal boards made more permanent, and all exposed terminal wires on both units should be suitably protected against possible injury during the transmitter unit's removal from, or re-insertion into, its case. See enclosures (S), (U), and (W).

(c) The tube clamping guides, particularly in the rectifier unit, should be improved for more ready insertion of tubes, as indicated in paragraph 7.

(d) Interference with upper panel guide pins damages upper front snap slides inside transmitter cases (see enclosures (R) and (X)); should be corrected in conformity with paragraph 4 of enclosure (G).

12. OPERATING FACILITY. The operating facility of the final sample equipment, while appreciably improved over the preceding models, is not yet suitable for service use; it is believed that this can be rendered satisfactory in the production models by carrying out the recommendations of enclosure (F), and reference (j). The principal deficiencies in this respect are:

(a) Insufficient visibility of M.O. graduations from above.

(b) Unsuitable or inadequate panel markings.

(c) Insufficiently secured knobs.

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(d) Unsatisfactory positioning detents.

(e) Excessive reaction, in I.F. unit, between antenna tuning and coupling adjustments, especially with antenna switch on "Fixed" antenna position.

(f) Failure to mark M.O. band switch "Pull to turn"; inexperienced personnel is likely to injure knob or shaft in attempting to shift bands.

13. OUTPUT INTO FIXED ANTENNA. Reference to enclosures (JJ) and (KK) shows the following full power output delivered in flight to the fixed antenna shown on enclosure (EE), with constants shown on enclosure (LL):

Frequency kcs	Antenna Current Amps.	Approximate Antenna Resistance Ohms.	Approximate Power to Antenna Watts.
300	1.2	25.6	37
544	3.6	2.8	36
600	3.8	2.4	35
3000	6.5	2.4	101
4080	7.0	2.75	134
6600	3.75	7.1	100
8160	2.5	30.	187
13575	1.5	48.	108

Both the I.F. and the H.F. units were satisfactorily matched into representative antennas of widely varying constants, including dummy antennas employing reactance and resistance values similar to those reported for P2Y-3 and PBY-1 fixed antennas in references (m) and (n), in all frequency ranges.

14. TRAILING ANTENNA OPERATION. Trailing antennas of various lengths were readily resonated, both on the intermediate and high frequencies. The following table, based on enclosures (JJ) and (KK), summarizes the output power data with trailing antenna; antenna resistances are based upon subsequent Q-meter measurements, with a probable accuracy of 10%.

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Frequency kcs	Antenna Length ft.	Approximate Antenna Resistance Ohms	Antenna Currents Amps.	Approximate Power to Antenna Watts
300	430'	10.	2.5	62
350	490'	8.	3.6	104
544	150'	4.3	4.3	79
544	494'	25.	2.5	156
600	430'	20.	2.7	146
3000	96'	47.	1.6	120
3000	254'	75.	1.1	90
4080	65'	60.	1.7	173
6600	35'	35.	2.1	154
6600	106'	70.	1.55	168
13575	11'	9.	4.5	180
13575	46'	25.	2.7	182

15. TRANSMISSION LINE OPERATION. Reference to enclosure (JJ) shows the following power output into phantom antenna resistors in the "Transmission Line" position:

Frequency kcs	Phantom Resistor Ohms	Power Output Watts
350	355	89
350	600	39
544	20	105
"	30	143
"	40	160
"	50	162
"	60	173
"	80	178
"	100	169
"	150	150
"	200	129
"	355	60
"	600	37.5

16. OUTPUT COUPLING. The coupling variometers employed in both the I.F. and the H.F. unit showed a satisfactory range of adjustment to match the required antenna constants, as well as to provide the required power reduction to one-quarter of full output. The I.F. coupling circuit, however, should be shielded from the antenna tuning and loading inductors to reduce the bad reaction from these circuits which at present causes erratic shifts in the

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positions of maximum and minimum coupling and renders the present dial calibration worthless. A less desirable, only partial remedy would be to calibrate the I.F. coupling dial throughout 360 degrees of rotation, instead of the present 90 degree sector graduated in 100 divisions (see enclosure (M)). Reference to columns 16, 21, and 22 of enclosure (JJ) shows the coupling variations encountered, the latter two columns showing one or more dial positions in which the electrical coupling passes through a minimum. Figures in quotation marks are estimated relative positions off the graduated sector. On the H.F. unit, maximum coupling was consistently obtained at 90 rather than the full 100 scale divisions; the governing factor in the manufacturing alignment of this dial should be coincidence of the minimum electrical coupling of each of the three H.F. coupling rotors with the dial zero position. The coupling in both the I.F. and H.F. units sufficed for full transmitter loading into antennae of from 50 to 60 ohms resistance; in the H.F. unit, shunt capacitors enable the transmitter to be matched into antennae of higher resistance up to ten thousand ohms with normal load and output, as shown by enclosure (KK).

17. HARMONIC RADIATION. The following figures were obtained by measuring the received signal strength at this station, both on fundamental and harmonic frequencies, while the airplane was flying at a distance of about ten miles and transmitting CW dashes on 4080 kcs. Reception was effected on an 85 ft. vertical single-wire antenna; the effective signal voltage was measured by alternate substitution of the output from a Model LN oscillator through an equivalent dummy antenna, in place of the vertical wire antenna with its actual signal. In the first set of readings shown below, an attempt was made to accentuate the second harmonic by coupling the antenna through a transmitter tank circuit resonant to 8160 kcs; in the second case, normal straight inductive coupling was employed to the 65 foot transmitting antenna.

Mean Received Signal on 4080 kcs	Mean Received Signal on 8160 kcs	Voltage Ratio	Second Harmonic Suppression
37,000 uV	9 uV	4110:1	72.3 DB.
16,000 uV	5.5 uV	2910:1	69.3 DB.

18. SIGNAL QUALITY. The audio-frequency characteristics of the signals received from the final model of the subject equipment are satisfactory, both on CW and MCW emission; keying "lilt" and vibration modulation became noticeable only in a moderate degree at the upper end of the high frequency range.

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19. SIDE TONE. The side-tone output was found adequate and the low impedance of the side-tone circuit satisfactory for absorbing excessive receiver noises during break-in operation. The side-tone volume control regulated the electrical output from zero to 6.8 volts, into the normal headset impedance of 600 ohms. The following data were obtained in the laboratory:

Volume Adjustment 1 to 10 Max.	Load Impedance Ohms	Output Volts	Output Milliwatts
10	20,000	7	2.7
10	600	6.8	85
10	300	6.7	160
10	30	4.8	820
10	15	3.57	940
10	12.5	3.25	925
10	2.5	1.10	500

Vol. 10	Internal	Circuit	Impedance	14 ohms
" 4	"	"	"	10 "
" 3	"	"	"	8 "
" 2	"	"	"	4 "
" 1	"	"	"	2.7 "

20. OPERATION WITH FREQUENCY METER. Operation with the Model LM Frequency Meter was satisfactory except in the selector switch Radio Test position, where insufficient signal was delivered to the frequency meter unless the latter was connected to the M.O. dial locking knob or some other metal object protruding through the oscillator compartment shielding. A suitable binding post should be added for this purpose on the front panel of each transmitter unit, in the production equipment.

21. FREQUENCY RE-SET. Flight tests to determine the frequency resetability were made in cooperation with the Naval Research Laboratory, where all frequency measurements were performed. Due to insufficiently rugged construction of the M.O. condenser drive, excessive frequency discrepancies were obtained when approaching the proper setting from opposite directions. Contractor has agreed to supply improved mechanism in production equipments, as required by reference (j).

22. ALTITUDE FREQUENCY DRIFT. Frequency measurements for drift with changing temperatures at altitudes up to 17,500 feet were taken in cooperation with the Naval Research Laboratory, throughout the frequency range of the equipment. The performance

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in this respect appeared to be, in general, of a satisfactory order.

23. BREAK-IN OPERATION. The break-in operation of the equipment was at first not satisfactory because of excessive transient reception noises and too great a time lag in receiver recovery to enable break-in operation at suitable operating speeds, with the RU-4 receiver adjusted to nearly full gain (10 uV. input for 2.5 volts output) for CW reception on the transmitted frequency. This original condition is shown by Oscillogram 33-A, enclosure (HH). Addition of a surge absorbing condenser eliminated excessive key sparking and reduced the relay lag somewhat, as shown by Oscillogram 39-A, enclosure (HH). To reduce the excessive transient noise and resultant receiver recovery delay, it was found necessary to add an additional set of contacts (#7 as shown in enclosure (L)) to each keying relay, and to alter the circuit so as to block the M.O. grids by opening these contacts whenever the key is released. Oscillogram 38-C, enclosure (GG), shows an actual increase in the receiver disturbance observed after the contractor had effected the above alteration; this, however, was corrected by minor further alterations as stated in paragraph 2(d) of enclosure (G), with the result that operation is now considered satisfactory at keying speeds up to 30 words per minute. Oscillogram 40-C, enclosure (GG), shows the final satisfactory operation at 544 kcs. The high-frequency transmitter unit, tested at a frequency of 8270 kcs, with the final circuit modification, gave substantially identical, equally satisfactory break-in keying results.

24. KEYING RELAY. The keying relays delivered on the equipment were found unsatisfactory in many respects, as enumerated under section "E" in enclosure (F). The modified type of relay, as finally installed at this station by the contractor's representative, eliminates most of the objectionable features and appears satisfactory for service use at speeds up to 30 words per minute. The old and new types of relays are shown on enclosures (BB) and (CC), respectively. Enclosure (DD) shows some receiver contact arm troubles experienced prior to strengthening of this item in the final relay modification.

25. EFFECT ON RECEIVER TRIMMING AND SENSITIVITY.

(a) H. F. Transmitter Unit: The stray capacitance of the receiver circuit wiring through the H.F. transmitter unit was measured as 27 micro-microfarads; its relatively low "Q" of 70.8 (at 5,000 kcs.) was measured prior to the use of ceramic bushings in the relay circuit, and indicates poor insulation quality. When receiving 8200 kcs. CW signals on an 85 foot vertical wire, connection of the RU-2 receiver through the H.F. transmitter necessitated a 35

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degree counter-clockwise change in the receiver antenna trimming, which brought the receiver output voltage up to within 2% of the output obtained when connected directly to the antenna. This is considered satisfactory.

(b) I.F. Transmitter Unit: Due to the insertion of the I.F. transmitter antenna loading and tuning circuits on the antenna side of the keying relay (in order to limit the voltage at the latter), all reception through the I.F. unit is effected through the reactance of these circuits, with resultant effect upon both the receiver input alignment and upon the reception efficiency. These effects were measured in the laboratory at reception frequencies of 350, 630, 1460, and 8200 kcs, and are tabulated on enclosures (MM) to (OO), respectively. Reference to these enclosures shows that the best receiver input alignment varies considerably with transmitter antenna tuning and loading, and in certain cases shows the reception efficiency, despite re-alignment, reduced to as little as one per cent of the sensitivity with direct-connected antenna. In actual use, no serious reception impairment will result when the I.F. reception frequency is equal to, or lower than, the transmitted frequency. Use of the antenna selector switch "F" in the "Fixed" position may prevent reception of moderately weak signals at a frequency somewhat above the transmission frequency, while reception of signals well above the transmitted frequency may be greatly impaired with switch "F" in the "Trailing" position. It is recommended that a warning be added to the I.F. transmitter face to re-align the receiver input trimmer after each change in transmitter antenna tuning, and it is further recommended that the GO-2 instruction book conspicuously call attention to the fact that excessive reception impairment may be reduced by throwing the Antenna Circuit Switch "E" (at present labeled "F") to the "Untuned" (at present "Transmission Line") position.

26. ELECTRICAL FAILURES. The electrical breakdowns encountered in the last series of tests are listed in enclosure (D), in paragraph 9 of enclosure (E), and in section B of enclosure (F). The altitude performance at 17,500 feet gave less trouble than was encountered with the earlier models of this equipment; with the assistance of the contractor's engineer, flash-over tendency at several points was remedied in the course of the tests. No satisfactory antenna terminal insulator bushing was submitted, however, and in the production equipments such a bushing of improved design must replace the improvised "stand-off" insulation installed at this station and shown on enclosures (M) and (T). If the recommended changes are incorporated in the production equipment, service operation at full power is expected to be dependable up to the specification altitude of 17,500 feet. The subject equipment was

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found capable of delivering very high R.F. voltages to the antenna, resulting in breakdown of several NAF-66405-3 patrol plane fairleads during tests when antennas shorter than the minimum recommended lengths (150' for I.F., 25' for H.F.) were employed. Successful corrective alterations were made on another fairlead of the same type, and are being recommended for all fairleads to be issued for use with the subject equipments.

27. VOLTAGE COMPENSATION. The line capacitor units provide compensation in increments of one-half microfarad, up to a total value of 7.0 mfd.; this compensation proved adequate for all generators tested, and allowed variation of key-down voltage in steps of approximately 2%, thus enabling compensated voltage adjustment within the required one per cent of the normal filament voltage. The change between compensation for CW and MCW was generally negligible; likewise, for any given P.A. plate current value, no appreciable difference in compensation requirement was found between the I.F. and the H.F. transmitter units. Changes in the transmitter power or resonance adjustment, as indicated by the P.A. plate current, required changes in compensating capacitance; with unchanged compensation, decrease from full to quarter power transmitter output (by antenna coupling reduction) was found to increase the filament voltage by six to ten per cent. Enclosure (PP) shows suitable values of compensation required in laboratory tests around 800 and 600 cycles with both an NEA-1A and an NEA-2 generator, and with an NEB-1A generator around its standard 800 cycle frequency; compensating capacities used in flight, with the NEA-2 generator, are shown on enclosures (JJ) and (KK). In the "Radio Test" position (not recorded on the enclosures) variation of compensating capacity had no effect, with the result that unavoidable changes in filament voltage from five per cent drop to two per cent increase were observed, with no apparent detriment to the tubes. No tube failures of any kind were encountered during this station's series of tests on the final sample equipment under severe operating conditions.

28. MECHANICAL RUGGEDNESS. Enclosure (F) sets forth numerous deficiencies in mechanical ruggedness of the model equipment; these should be corrected in the production equipments, with particular attention to corrosion protection, securing of knobs and dials, and careful workmanship on ceramic insulating parts.

29. CONCLUSIONS AND RECOMMENDATIONS. If the changes recommended in enclosure (F) and the other required modifications are properly effected by the contractor, it is the opinion of this station that the production equipment will be suitable for the intended use, and will constitute a distinct advance over all previous types of patrol plane radio equipment. In order properly

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to determine the satisfactory correction of defects, it is strongly recommended that, prior to issue of production models to the fleet, one or more of the production equipments be given an accelerated service test of approximately 50 hours operation in flight on various frequencies, including several flights at maximum specified altitude.

30. It is requested that two copies of the Naval Research Laboratory's report on the subject equipment, upon completion of same, be furnished this station for information and future reference.

V. C. Griffin.

Copies to:
BuAero (3)
BuEng
NAF Phila.

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NAVAL RESEARCH LABORATORY
Anacostia Station
Washington, D.C.

Unclassified
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29 March 1935

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

Subject: Aircraft - Tests of Model GO-1 Transmitting Equipment. (BuEng.Prob. A5-7)

Reference: (a) BuEng let.F42-1(11-8-W3) of 17 November 1934.
(b) Specifications for Patrol Plane Radio Transmitting Equipment.

1. It is requested that flight tests be conducted on the Model GO-1 transmitting equipment in accordance with ref.(a).

2. In conference with personnel from the Naval Air Station the flight tests were discussed and data will be taken on the following tests.

(a) Character and intensity of interference in radio receiver due to transmitter noises at 355, 440, and 544 kilocycles on the I.F. unit and at 4135, 8270, and 12,405 kilocycles on the H.F. unit. Report on ability to copy through with normal break-in operation and compare with reception with transmitter dead.

(b) Keying action. Report sticking of the keying relay contacts or any other troubles experienced with the keying relay.

(c) Modulation effects due to plane vibration which reacts on frequency stability to give a bad note, especially on the H.F. unit.

(d) Check resetability in accordance with instructions given during flight. Note time for resetting including the changing of the antenna length.

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(e) During the altitude tests up to 17,500 feet note whether there is any arcing or shorting across the high voltage terminals. A drift test will be run at each of two frequencies, 544 and 8270 kilocycles, while climbing to 17,500 feet. The data will include the temperature, altitude, and time at which the temperatures and altitudes are read. After reaching the maximum altitude the transmitter will be shut off and allowed to cool ten (10) minutes before descending. A drift run will be made on the descent at the same frequency as that used during the climb.

(f) Any other difficulties encountered with the equipment and general comment on the operation of the transmitter will be included in the report.

(g) The Model GO-1 transmitting equipment was delivered to the Naval Air Station, Anacostia, D. C., on 28 March 1935.

H.R. Greenlee.

Copy to: BuEng.

ENCLOSURE (A)
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COPY

U. S. NAVAL AIR STATION
ANACOSTIA, D. C.

[redacted]

28 April 1935

MEMORANDUM

Subject: Summary of GO-1 Tests.

1. KEYING ACTION.

(a) A preliminary DC relay was installed by the contractor in the I.F. transmitter, while the AC relay in the H.F. transmitter was modified for DC operation and connected in parallel with the I.F. relay; 14 volts D.C. (separate batteries) were used for oscillogram. Key was operated by automatic vibroplex key, slowed down to send dots at rate of about 5 per second (corresp. to a transmission rate of about 10 words per min.)

(b) The keying sequence, as shown by the oscillogram, is as follows:

After less than .01 sec chatter, the "bug" contacts close the key; the receiver antenna opens about .01 sec thereafter. The inductive kick denoting completion of the HF relay travel occurs about .02 seconds after key closure; that due to the I.F. relay .005 seconds later. Just before complete closure of the I.F. relay, bad clicking surges occur in the receiver output, at about the time of closure of the transmitter power contact. The transmitter antenna relay contact chatters badly for about 0.015 seconds, causing continued bad clicks in the receiver of blocking intensity. Blocking of the receiver is shown by the dip in the axis of the receiver output trace. The blocked receiver loses its sensitivity to the r.f. clicks and commences to reproduce the 800 cycle transmitter side tone, fed into it thru the ICS jack. Steady state conditions are reached about 0.04 seconds after key closure.

(c) About 0.02 seconds after opening of the key, violent receiver clicks are experienced, just before opening of transmitter power contacts. Possibly this is due to ungrounding of the receiver antenna post while momentary arcing occurs in the trans.power contacts. Severe receiver disturbance continues while the transmitter power pack condenser continues supplying transmitter power until the transmitter antenna contact opens, about 0.028 seconds after key opening. The receiver remains blocked for about 0.03 sec longer before it recovers and normal steady reception is restored.

(d) Note that the duration of received signal is about 0.06 sec. only, while the interval between transmitted dots is on the

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MEMORANDUM: 4-28-35

Subject: Summary on GO-1 Tests.

order of 0.12 seconds; this indicates that the received signal would disappear completely at a sending speed of about 18 w.p.m. (i.e. break-in between dots and dashes, not merely between words).

(e) Good break-in action at speeds of 25 w.p.m. is believed possible if the following measures are taken:
(1) Eliminate trans.antenna contact chatter.
(2) Ground receiver ant. post earlier, unground later.
(3) Speed up keying relays slightly to complete action in about 0.015 seconds, or not over 0.02 sec.
(4) Eliminate undue arcing at power contacts if necessary.
(5) Separate protective relays appear desirable at all receivers to dissociate the receiver antenna contacts from the transmitter.

2. MISCELLANEOUS COMMENTS.

(a) Apparently lower I.F. output than GO in flight.

(b) Appreciable flip-flop frequency instability 4135 and 12405 kcs.

(c) Antenna reel unsuitable. See separate sheet.

(d) Altitude arcing into detent roller pin, HF unit.

(e) Altitude arcing in I.F. keying relay (floating shield).

(f) Many riveted joints in frame structure have resistance greater than 0.0025 ohms, the maximum permitted by airplane bonding specs.

(g) Some long circuitous ground connections inside transmitter unit have excessive impedance.

(h) Primary of power transformer shorted to core, probably as result of r.f. induction; power unit contains no internal connection to ground (chassis) whatever; suggest grounding direct or thru by-pass condensers.

(i) Main frequency determining dials not visible in flight thru small window in bottom; must be easily readable in poor light from within 30 degrees from vertical.

(j) Dial lock screws pretty small and weak; suggest replacing #5 screw thread by at least #8.

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(k) End stops desirable on some dials (not internally associated variable) to prevent tuning to resonance off graduated scale, and preventing scoring graduated portion of dial by lock device.

(l) Some controls increase with frequency, others increase with inductance (I.F. variometers, but not H.F. variometers). Should be made consistent throughout.

(m) No marking for ON--OFF position of compensating condensers.

(n) Shock mounts are 35 lb. rating each, 6 units; appear stiffer than necessary, suggest replacing by 30 or 25 lb. units.

(o) Snap slides too weak and flimsy; suggest replacing by more rugged snap slides as used with original Stromberg-Carlson receivers.

(p) Catches holding units together are too weak.

(q) Poor bonding between the 3 units.

(r) Keying relay originally no good; temporary D.C. relay much better, but not yet satisfactory.

(s) Not much power reduction from FULL to 1/4 power, when short or fixed antenna used on I.F.

(t) Side tone system does not drain off excessive receiver clicks and permits excessive receiver response when transmitting and receiving on same frequency. Use method suggested for GO by Anacostia, which requires additional contact in relay.

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Radio Test Section
U.S. NAVAL AIR STATION
Anacostia, D.C.

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17 August 1936

Memorandum on GO-2 Test Status (to date).

1. Since recent advance report to NRL, following additional tests have been completed:

a. Bench tests show satisfactory coordination with following generators used as power supply:
   NEA-2, at 800 and 600 cycles
   NEA-1A, at 800 and 600 cycles
   NEB-1 emergency gas engine power unit, 800 cycles.
b. Excessive resistances have been found in framework structure and in bonding to panels, especially in I.F. unit where certain parts of the frame showed more than 1 ohm resistance to other portions of same framework, with only riveted and screwed joints intervening.
c. Altitude flight misadjustment breakdown test on 13,575 kcs failed to produce any breakdown.
d. On 544 kcs with 150 mmf fixed antenna, flying at less than 1,000 feet, use of MCW caused electrical breakdown of, and permanent damage to, ANTENNA SWITCH F and ANT COIL SWITCH G of I.F. unit.
e. At 18,000 ft altitude when employing 4135 kcs into 10 ft. trailing wire antenna, use of MCW produced flash-over and damaged ANT CAP SWITCH G on H.F. unit.

2. The equipment has been turned over to representatives of the contractor who called for it, by air, on 14 August 1936.

3. In comparison with the GO-1 model originally submitted, the following points are noted:

a. The change to Inductive Antenna Coupling considerably facilitates proper tuning adjustment and prevents radiation on undesired frequencies; except for overcoupling of the HF unit into antennae of 10 ohms or less, there is now a good flexibility of antenna matching adjustment.
b. Frequency drift and telegraphic lilt are still bad on HF.
c. CW telegraph note still bad on HF, especially at and above 8 mcs, appears to be vibration frequency modulation.
d. Break-in relay design and operation improved, but not yet acceptable.
e. General electrical dependability still unsatisfactory, as indicated by intermittent M.O. failure to oscillate, low MCW output, and insulation breakdown at several points.

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f. Still no satisfactory means of power reduction.
g. Voltage compensation adjustment requires changing with any changes in tuning, type of emission, or frequency.
h. Still poor bonding (excessive resistance) in frame structures and between units.
i. Keying system will now not operate properly with standard Navy key having frame grounded to airplane metal hull.
j. Shock suspension not yet satisfactory.
k. Accessibility of rectifier unit, originally poor, has been further impaired.
l. Tube sockets still unsatisfactory from standpoints of tube renewal without damage, and violate insulation material requirements of specification.
m. Originally excessive weight has been further increased (?).
n. In addition to the above, numerous other defects and inadequacies have been found in the GO-2 model during the extended tests just completed, and are listed below under suitable headings.

4. An attempt is herewith made suitably to classify the various comments, with the unavoidable result that in a number of cases the same features are discussed under several headings. Figures in parentheses following comments refer to paragraphs of the specification.

a. GENERAL:
1. No Instruction Books furnished.
2. Total weight now 139 lbs, 5-1/2 oz. which is 14 lb. 5-1/2 oz. in excess of 125 lbs allowed by (2-36).

b. MATERIALS:
1. Tube sockets of phenolic material violate spec. requirement for ceramic insulation on HF. Metal top ring would seem further to increase losses and be conducive to breakdown.
2. Several cases of unplated metal subject to corrosion for example on switches, and brass screws holding aluminum shielding bulkheads (HF M.O. shields).

c. MECHANICAL DESIGN & WORKMANSHIP:
1. Relays insufficiently rugged, tend to bind.
2. Isolantite piece cracked on one relay.
3. Receiver contact (antenna) on relay fails to close properly at times.
4. Framework joints show excessive resistances, up to more than 1 ohm between points on same frame.
5. Tube elements show excessive vibration when observed in flight (removed from shock mounting): this appears largely due to the manner of supporting the plate eccentrically by a single supporting wire.

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6. Shield on sides of HF M.O. compartment appears too flimsy and is not properly screwed down: should be made more rigid and secured properly by uniform and plated screws.
7. Question desirability of letting M.O. compartments rest on bottom of outer case with variable rubbing contact at rear, likely to cause vibration reaction.
8. All lead-out insulators and ground binding posts are not adequately secured or locked against turning or loosening, and should be identified by suitable marking. Recommend providing "Rajah" connectors which now have been adopted as standard.
9. Emission and Frequency Unit selector switches on rectifier unit have no lock nuts on one end of assembly studs. Design should be improved to prevent twisting out of alignment if insulation material shrinks or studs loosen up.
10. Shock mounting buttons not locked on studs, loosen readily.
11. Several shafts and dials loose and "wobbly", such as Fil Rheostat.
12. M.O. adjustment shaft (both HF and IF) insufficiently rugged, was found loose due to inadequate securing of rear bearing on condenser frame: resultant loss of re-set accuracy.
13. M.O. Coil Switch on HF unit cuts and binds, works very hard.
14. M.O. Capacity Switch on HF unit shows excessive end play and resultant excessive variation in contact resistance, and exhibits frequency shifts on re-sets. Recommend strengthening design of all similar switches.
15. "Clicker" detent action is generally weak on most controls, to prevent inadvertent misadjustment with heavy gloves in cold weather.
16. Original weak securing bails have been retained but are now superfluous.
17. A number of snap slide studs have loosened where they are riveted to outer cases. Ruggedness at this point must be increased.

d. PERFORMANCE:

1. The following Breakdowns and Failures were experienced:

   a. 1000 v contact on IF-HF switch on rectifier unit flashed to ground due to inadequate insulation.
   b. I.F. Keying relay stuck at times.

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c. Receiver antenna contact in relay sticks intermittently.

d. Rectifier tube twisted loose from base, could not readily be removed due to great inaccessibility of rectifier unit.

e. P.A. tube in HF unit obtained cracked base shell while attempting to remove same from "trick" socket.

f. Antenna Switches F and G in IF unit were damaged by flash-over while operating on 544 kcs MCW into fixed (150 mmf) antenna. Recommend increasing insulation and providing protective horn gap.

g. Altitude test broke down and damaged insulation on HF Ant Cap Switch G, operating on 4135 kcs MCW into short 10 ft trailing wire, at 18,000 ft. Recommend increasing insulation and providing protective horn gap.

h. Accidental touching of side tone cable plug to ground (fuselage) blew fuse, rendering side tone circuit inoperative. See below under Electrical Circuit heading.

i. Keying relay is actuated by grounding of key base to fuselage. See further under Electrical Circuits.

j. Output of both receivers was mixed by original side tone circuit, interfering with "split phone" reception. Contractor's engineer corrected this.

k. Antenna wire burned through (inside fairlead) with resultant loss of trailing antenna on several occasions, likewise fairlead was charred and damaged, when transmitting on very short (30 ft) trailing antenna. This shows more power output on such antenna than heretofore available; recommend suitable warning plate on HF and IF units, requiring at least 25 ft trailing antenna for HF, and 150 ft for IF transmission. Even with no antenna paid out, the HF unit will resonate into the antenna drawn up in the fairlead, with resultant excessive voltages. Possibly horn gaps in units will be sufficient protection against damage from operators' mistakes in this respect.

Note: Additional details on antenna loss: 30 ft trailing antenna, 600 kcs MCW, Ant. Current 1.5 a.

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2. The following characteristics of R.F. Emission were observed:

a. Excessive gradual drift, more than 40 kcs at 13,575 altitude temperature test.
b. Excessive lilt and short time drift, sufficient to disrupt communication on 8270 kcs due to drifting out of receiver beat note on successive transmissions less than one minute apart.
c. Ragged CW note (vibration modulation) 8270 kcs and 13,575 kcs.
d. M.O. of HF unit failed to oscillate at intervals, cause undetermined.
e. M.O. of HF unit gave poor re-sets due to varying switch contacts and defective M.O. condenser drive.
f. HF unit gave some indication of tendency to oscillate at two frequencies less than one kilocycle apart.
g. On numerous occasions, when switching HF unit from CW to MCW, output power fell off materially (instead of normal rise), together with excessive plate current increase and voltage reduction due to insufficient compensation. Cause of this behavior undetermined, but probably related to occasional M.O. oscillating failure, and possibly due to various poor contacts. Especially in the morning before thoroughly heated up there is something seriously wrong with HF unit, which contractor's engineer could not explain, locate, or remedy. May require major redesign.
h. In view of over-coupling even in zero position of antenna coupler when employing fixed (low resistance) antenna, minimum coupling should be further reduced, especially in lower end of HF band.
i. Percentage of MCW modulation appears low: modulation frequency was observed to be 1600 cycles in place of the 800 cycles required by (3-23).

3. Performance, Miscellaneous Observations:

a. In the Radio Test position it was at times very difficult to obtain enough input to the LM frequency meter coupled to the antenna. See below under Elec. Circuits.
b. On Radio Test position, when depressing key, NRL on ground intercepted strong signal.
c. Often unable to obtain appreciable power reduction with antenna coupling: in cases where such reduction obtainable, readjustment of compensating capacitor was necessary to avoid undue voltage rise (often more than 20%).

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d. Shift from CW to MCW was found to change filament voltage from 6 to 9%, requiring change of compensating capacitor by about 1.5 mfd when operating on full power output. Due to the greater plate load in normal operation on IF as compared to HF, switching from HF to IF generally also required an increase in compensation. (3-24: 4-11)

e. When relays were in proper operating condition, fairly good break-in reception was obtainable, both on HF and IF transmission and reception. Correction of mechanical relay defects and connection of power contacts of the two relays in series, it is believed will make break-in operation satisfactory.

f. Shock mounting during flight and landings was found to be somewhat too "wobbly" at bottom, and too rigid at the top of equipment. See further under Installation, below.

e. FACILITY OF OPERATION

1. Too many controls and dials near bottom of equipment for greatest operating convenience: equipment gives impression of being designed for mounting on elevated bench, rather than just above deck, well below operator's eye level.
2. Window for Ant Tun Coil H (HF unit) should be enlarged to read setting properly, so that at all times at least 2 successive numerals can be seen.
3. On rectifier unit freq. range and emission selector switches present dials do not indicate positively enough: recommend using switch knobs similar to GP-1, with pointers and engraved panels (or escutcheons). The same style of knob and pointer also appears preferable for many switches on RF units of equipment.
4. Side tone control too easily confused with filament rheostat dial. Recommend exchanging positions of these two for better access to fil control, and making side tone regulation by means of locking screw driver adjustment.
5. Difficulty was experienced in finding M.O. "A" and "O" switch combinations to set on uncalibrated frequency of 6000 kcs, 36 combinations being obtainable. Recommend combining this MO condenser and coil switch into a single progressive switch, as is done with P.A. tuning switch E, if this is feasible.

6. The R.F. meters measure antenna current in one position of the output switch, and change to tank current meters as this switch is changed, making a comparison of best output tuning setting impossible and confusing the operator who will prefer a 4 amp RF (tank)

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current setting to one giving him only 1 amp RF (into antenna). R.F. meters should be directly connected to antenna output terminal at all times. These meters should be changed to "expanded scale" type to facilitate reading low currents, and should have white markings on black background.

7. All meters should have white scales on black background.
8. Filament meter should have red mark at 10.0 volts.
9. Plate milliammeter should have normal full load CW currents marked in red, namely 375 m.a. for HF and 425 m.a. for I.F. operation, with suitable designation.
10. Some index escutcheons (like H on IF unit) are too high, leaving gap to dial and do not enable accurate dial readings.
11. Use of same designating letters for different type adjustments in HF and IF units is confusing. Recommend continuing through alphabet or using numerals on one and letters on other unit, to avoid confusion in reading or recording.
12. Adjustment designation symbols should progress in same order as tuning adjustments, for ease in logging and rapid tuning. Thus antenna adjustments should follow and not precede P.A. tuning. Also some questions about best terminology for various adjustment designations, and direction of increase. Recommend discussion of this in conference together with NRL, and final instructions to contractor.
13. M.O. coil switch and M.O. capacity switch may be misadjusted due to absence of end stops.
14. Recommend addition of time delay relay to protect rectifier tubes, or at least addition of suitable red warning plate on front panel.
15. No initial capacity is marked on compensating condenser plate. Is this required?
16. Recommend changing marking of jack name plate from "Rec.Tel. 1, Rec.Tel. 2, Tel. Key" to read "I.F. Rec. Tel., H.F. Rec. Tel., Tel.Key".

f. INSTALLATION FACILITY

1. Difficult to install units due to shock mounts not separating. Recommend departure from spec. dwg. 40c, in interests of installation and servicing accessibility: (a) Lower bottom mount to enable upper mounting buttons to be doubled, in tandem, for greater upper resiliency and for stiffening bottom. (b) Provide positive but detachable connection between shock mounts and cases, such as by snap slides similar to receiver mount.

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2. Access to power cable connections difficult through rectifier interior. Recommend external connector block on top of rectifier unit, with cover, or preferably connection by means of separable plug such as new Breeze or Cannon type, located for access near top of rectifier unit.
3. No locking catch provided for std Navy key plug, which will pull out readily.
4. Unable at present to use standard key with case grounded: the transmitter should be required to function with this.
5. Desirable to lock side tone plugs in place, and to mark plugs HF or IF.
6. Recommend appropriate designation and marking of all antenna and ground terminals.

g. SERVICING AND MAINTENANCE:

1. Rectifier unit is extremely inaccessible. To get at it at present requires following operations:

   (a) Remove all antenna and ground connections
   (b) Remove both HF and IF unit from cases
   (c) Unscrew 11 round head screws holding each side box to rectifier unit.
   (d) Unclasp 4 (unnecessary) spring hasps.
   (e) Unscrew screws holding top and bottom rubber shock mountings.
   (f) Remove side panels from rectifier unit and lay on its side, taking great care not to damage attached projecting spring contacts.

2. Recommend guard protecting spring contacts on rectifier unit, to avoid damage when laid down.
3. Rectifier name plate should be attached to permanent rectifier portion instead of detachable door cover.
4. Recommend suitable marking and designation on front of relay covers, rectifier tube access door, internal M.O. shields, and all other parts subject to misplacement. Attempt to replace relay covers backwards may cause damage due to unsymmetrical shield baffle.
5. Lack of accessibility to units during operation makes trouble shooting or bench testing very difficult. Recommend adding suitable access doors or plates to both HF and IF units for observation and P.A. tube replacement.
6. Internal parts are marked only with contractor's own designation, and not USN type number.
7. Tube sockets require non-conventional performance to change tubes, rendering this operation difficult where socket is not fully visible, and causing tube breakage.

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8. Fuse panel is not adequately marked: recommend plainer markings, with spare fuses to be carried on inside of rectifier access door, on insulating mount to enable testing without removal.
9. Designate power terminals suitably, including voltage and polarity.
10. Designate and mark M.O. trimmer condensers, C16A and C25B.
11. Rear framework of both HF and IF transmitter units provides no protection to fixed resistors mounted behind same, with resultant damage when equipment laid on its back during servicing. Recommend extending protective frame or sub-frame behind these resistors. All units should be so constructed that they can be laid on any face (with possible exception of top) for servicing, without incurring damage.

h. ELECTRICAL DEPENDABILITY:

1. Keying relay coils should be impregnated for tropical use.
2. 1000 volt contacts in rectifier unit switches need additional insulation to avoid breakdown.
3. 1000 volt side contact springs inadequately insulated.
4. 1000 volt potential on resistors R6.2A and R6.2B inadequately insulated to support frame by fibre washers.
5. Recommend increasing insulation on RF antenna switches which broke down, and considering horn gaps for protection in case of excess potential.

i. ELECTRICAL CIRCUITS:

1. Increase protection to receivers by wiring power contacts of both relays in series, so power can't come on unless both relays are closed, hence both receiver antenna terminals grounded.
2. Avoid mixing receiver output through common side tone circuit. Has been corrected in model.
3. Re-design key circuit to bring one terminal of key to ground (negative DC) potential.
4. Keep RF meter in antenna circuit regardless of output switch position.
5. Stabilize and protect side tone circuit to avoid damage or fuse blowing from shorting plug terminals: some reduction of maximum side tone below present 16.5 volts (across 300 ohms) is permissible, while keeping its impedance (looking in) as low as practicable.
6. Note that side tone plug leads must have internal connections crossed to have output TIP at ground

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potential, while on Rectifier unit the jack SLEEVE should be grounded to panel. Also sleeve of Key jack.

7. Consider feasibility of separate transmitter coupling post for connection of LM unit, in case Test position gives inadequate signal.

5. For purposes of future specifications, it is suggested that the following items or requirements be given consideration:

(a) Definition of CW beat note quality, for example requiring ___% of the received signal tone energy to be concentrated within plus to minus 50 cycles of an average received 1000 cycle note. This could be measured by insertion of band pass filters of known attenuation.

(b) It is believed that the mounting layout can be improved over spec sheet 40 c.

(c) It is suggested all side tone & key plugs be locked in place: the new Breeze or Cannon plugs might be considered.

(d) Suitable Plug Connection is recommended for the power supply cable (s).

(e) It is believed desirable that all dials and adjustments be readable from 45 degrees to either side, and from any height from the horizontal up to 60 degree inclination above the bottom of the panel, 45 degrees above the top of the panel.

(f) Keying circuits should have one side (connecting to frame of the key) at Ground (D.C. negative) potential.

(g) Key and side tone jack sleeves should be at ground potential.

(h) Output requirements into lower antenna resistances appear desirable, and can be formulated as soon as measurements on patrol plane fixed antennae have been taken.

(i) Short-circuiting either side tone jack should cause no damage nor blow fuses.

(j) For servicing purposes, each unit, when removed from its case, shall enable being laid on any of its faces without likelihood of being damaged.

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6 December 1936

Summary of GO-2 Tests at N.A.S. Anacostia:

Mon. 16 Nov: Equipment received from N.R.L: tested on bench.

Tues. 17 Nov: Equipment and suitable antenna installed on XRE-2 Bellanca Radio Test plane; examination of exterior of GO-2.

Wed. 18 Nov: Flight #1; 2 hour familiarization overall test.

Thurs. 19 Nov: Flight #2: 1-3/4 hr: 350 kcs alt. freq. drift; trouble with both relays. Altitude reached, 17500 ft.

Fri. 20 Nov: Flight #3: 2-1/4 hrs; Freq. re-sets for NRL on 350, 544, 4135, 8270, 12405 kcs.

Flight #4: 2 hrs; 4135 kcs alt. freq. drift for NRL; poor reception unless relays energized.

Sat. 21 Nov: Flight #5: 2-1/2 hrs: general altitude breakdown test. Numerous failures, especially 544 and 3000 kcs.

Mon. 23 Nov: Flight #6: 2 hrs: 17,500 ft. alt. drift test, 12405 kc. Flight #7: 2-1/4 hrs: 17,500 ft. alt. drift test, 544 kcs.

Tues. 24 Nov: Flight #8: 2-1/4 hrs: 20,000 ft. breakdown, 300,544, 3000 kc. Troubles due to sticking M.O. switch, P.A. switch arcing safety gap flashover at low altitude, fairlead breakdown.

Flight #9: 3/4 hrs: 8000 ft breakdown test on 544 kcs, equipment and fairlead.

Wed. 25 Nov: Flight #10: 2 hrs: 18,000 ft breakdown, 544 & 350 kcs: Antenna insulator on GO-2 arcs over.

Flight #11: 2 hrs: 18,000 ft breakdown, 3000, 4135, 8270, 13575 kcs. P.A. tank condenser sparks across relay antenna pigtail charred, relay catwhisker burned off, and miscellaneous corona.

Thurs. (Thanksgiving)

Fri. 27 Nov: Equipment repaired and reconditioned during forenoon.

Flight #12: 2-1/2 hrs: 20,000 ft breakdown investigation 350, 544, 3000 kcs. Main breakdowns at Ant. Selector switch, Ant. Loading coil, Ant. Capacity switch, and beneath H.F. unit relay.

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Sat. 28 Nov: Flight #13; 2 hrs; 60 miles distance, up to 11,000 ft. 544, 350, 3000, 6600 kcs, trailing & fixed ant. Test tuning & break-in. Several dials & knobs loose, misaligned, or sticking.

Mon. 30 Nov: Forenoon spent in making repairs & alterations.

Flight #14: 2 hrs; 17,500 ft breakdown tests on 350, 544, 3000, 4135, 6600 kcs. NAF patrol plane fairlead failed. Flashover in GO-2 on 3000 kcs when using 13' antenna.

Tues. 1 Dec: Flight #15: 3 hrs; antenna resonating & coupling at full and 1/4 power, 300, 600, 3000, 6600, 13575 kcs.

Flight #16: 1-1/2 hrs; antenna tuning & coupling on 4080 & 8160 kcs; measured 2nd harmonic on 4080 kc fundamental, 70 db down.

Wed. 2 Dec: No flights, fog all day; measured reception effects (attenuation, de-trimming) through GO-2 in laboratory, on 350, 630, 1460, and 8200 kcs.

Thurs. 3 Dec: Poor flying weather; Ran GO-2 in laboratory on NEA-1A, NEA-2, and NEB-1A generators, measuring compensation required and voltage changes with faulty compensation. Made laboratory breakdown tests on several fairleads with short indoor antenna on 544 kcs; Anacostia modification of NAF VP fairlead OK.

Fri. 4 Dec: Laboratory determination of IF mis-coupling observed in flight; several defective contacts adjusted.

Flight #17: 2 hrs; 21,600 ft altitude check on equipment, in connection with VP fairlead on 544 kcs 100 ft. and fixed antenna; resonated fixed antenna at half-wave fundamental, 9750 kcs.

Sat. 5 Dec: 8:15 a.m. to 5:00 p.m. taking break-in keying oscillograms, 544 and 8270 kcs transmission and reception. Observed effects of relay clearances, key sparking reduction by condensers, etc.

Mon. 7 Dec: Detailed examination and remaining minor tests.

Total Flights: 17 Total Flying Time: 33-3/4 hours.

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Summary of GO-2 Tests N.A.S. Anacostia, 7 Dec. 1936.

Outstanding Unsatisfactory Features:

1. KEYING RELAY: See detailed list of troubles. Numerous poor and sticking contacts. Too delicate for service use. Excessive key sparking. Receiver key clicks bothersome at high gain, delay normal rapid restoration of reception.

2. LACK OF M.O. DIAL VISIBILITY: unreadable in poor light or from 45 degrees from above.

3. KNOBS, DIALS, and DIAL LOCKS still give trouble in many instances due to poor design or workmanship. POSITIONING DETENTS frequently too weak or misaligned.

4. INEFFICIENT OUTPUT with shunt capacitors (resistor losses).

5. ATTENUATION & DE-TRIMMING OF RECEIVER, by I.F. unit antenna loading and tuning circuits which are not cut out by keying relay.

6. I.F. ANTENNA TUNING REACTION ON COUPLING, due to lack of shielding. This interferes with facility of adjustment and probably contributes power losses. Rotor position for minimum coupling has been found more than 60 degrees (angular) off the marked zero coupling position, and shifts with antenna tuning adjustments. Also some reaction on P.A. tuning.

7. NUMEROUS MECHANICAL & ELECTRICAL DETAILS, such as r.f. meters, dial terminology, defective contacts, misalignment, etc.etc. as listed hereafter.

8. OVERWEIGHT.

9. SOME REMAINING BREAKDOWN TENDENCIES AT ALTITUDE: especially antenna terminal insulators, antenna selector switch on IF unit, and bottom of HF break-in relay. General altitude performance has been rendered satisfactory (although only by temporary improvisation) in the course of Anacostia tests.

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Previous Defects Corrected:

1. FREQUENCY STABILITY and character of telegraphic CW signal now appear acceptable.
2. COUPLING AND OUTPUT into low resistance antennae (except for (4) and (6) above) now satisfactory: power can be reduced to one-quarter by reducing coupling.
3. DETACHABLE MOUNTINGS materially improve installation and accessibility of units.
4. FRAME CONSTRUCTION now OK for bonding and protection.

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C O P Y
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8 December 1936

Anacostia Comments on GO-2 Equipment. (3rd Submission)

A. KNOBS, DIALS, MARKINGS: (all units)

1. "Ant.Tun.Coil" increases numerical setting with inductance, but "P.A.Tun.Coil" decreases numerical setting with inductance; other similar discrepancies confuse operator. ALL controls should increase (clockwise) numerically with increasing frequency, and be designated by names avoiding confusion. Retain numerical increase of Coupling as rotated clockwise.

2. All rotating switch knobs proposed are confusing to operator as to setting, in flight. H.F. M.O. Coil Switch knob rivet not readily visible in flight; other switch knobs readily mistaken end for end because of bright band passing through full length; Side Tone index mark too inconspicuous, readily obscured by dirt & salt water effects.

3. Panel markings in general too small to be readily visible in flight, especially their Designating Initials. Suggest the latter letters be conspicuously engraved, in large size, on all respective dial and switch knobs, and filled in with white for visibility.

4. H.F. Unit antenna tuning coil dial insufficiently graduated for recording exact settings; provide 100 divisions instead of 10 on exposed "units" dial.

5. Following sequence and terminology is preferred for I.F. UNIT:

Proposed in D'w'g.ESX-610997:	Desired:
(A) M.O. COIL SWITCH	(A) M.O. TUN. STEP
(B) M.O. TUNING COND.	(B) M.O. TUNING
(C) P.A. TUNING SWITCH	(C) P.A. TUN. STEP
(D) ANT. COUPLING	(H) ANT. COUPLING
(E) P.A. TUN. COIL	(D) P.A. TUNING
(F) ANTENNA SWITCH 1 Fixed 2 Trail 3 Tr. Line	(E) ANT. CIRC. SW. 1 Shunt Cap. 2 Tuned 3 Untuned
(G) ANT. COIL SWITCH 1, 2, 3.	(F) ANT. TUN. STEP 1 Max.Load 2 3 Min.Load
(H) ANT. TUN. COIL	(G) ANT. TUNING

ENCLOSURE (F)
Page 1 of 12 pages.

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Anacostia Comments on GO-2 Equipment (3rd Submission)

A. KNOBS, Dials, Markings (Cont'd).

6. Following letter sequency & terminology preferred on H.F. Unit:

ESX-610997:	Preferred:
(A) M.O. COIL SWITCH	(A) M.O. TUN. STEP
(B) M.O. TUN. COND.	(B) M.O. TUNING
(C) IA COIL SWITCH	(C) I.A. TUN. STEP
(D) IA TUN. COND.	(D) I.A. TUNING
(E) ANT. COUPLING	(J) ANT. COUPLING
(F) P.A. TUNING SWITCH	(E) P.A. TUN. STEP
(G) P.A. TUN. COND.	(F) P.A. TUNING
(H) ANT. CAP. SWITCH Off 1, 2, 3, 4	(G) ANT. SHUNT CAP. Off 4,3,2,1 Max.Cap.
(J) ANT.TUN. COIL Exposed dial 0-10	(H) ANT. TUNING Mark exposed dial 0-100

7. Some external dial index marks leave too much gap to dial; Dwg. ESX-610997 shows no index marks, but index plates appear high. Provide conspicuous index marks as close as possible to all dials, without unnecessary parallax.

8. Dial lock knobs should be hollowed out (front face) and shaft strengthened: #6-32 brass shaft too weak, easily bent.

9. Several knobs & dials worked loose in operation; single set screws, or double set screws on plain shaft without flat spots, NOT considered satisfactory anchorage.

10. Dial lock knobs should positively be kept from backing off too far, to prevent loss, or interference with M.O. adjustment etc, or loosening & jamming of lock friction plate. Stop missing from I.A. locking knob in HP unit (no space for same).

11. Positioning detent action on many switches unsatisfactory, and detent mechanism not rugged enough. Especially HF-IF switch on rectifier, Ant.Switch on IF unit, Ant.Cap. Switch on HF Unit, HF unit P.A. Tuning Switch, and I.F. MO coil switch.

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Anacostia Comments on GO-2 Equipment (3rd Submission). 8 Dec.1936.

B. REPAIRS & ALTERATIONS EFFECTED AT ANACOSTIA

1. HF unit M.O. switch stuck twice; scrap piece of bakelite removed.

2. IF keying relay holder magnet connection broken; repaired twice.

3. HF antenna relay wiring corrected to connect ANT to receiver.

4. HF antenna ammeter taken out of receiver antenna circuit, and 0-5 ampere meter replaced temporarily by 0-7 amp meter borrowed from GP-1 equipment; 0-5 ampere range inadequate.

5. Incomplete wiring of HF antenna capacity switch H corrected to cut in capacity on steps 1-2-3-4.

6. HF keying relay receiver antenna contact repeatedly failed to give proper reception, especially when D.C. switched off transmitter. Repeated adjustments made by contractor's engineers.

7. Both relays remained energized even after withdrawal of key plug, until IF relay cover removed; this trouble corrected by Contractor's engineer.

8. HF relay antenna pigtail lead burned off by arcing against cover. Replaced by shorter, more direct pigtail.

9. HF relay receiver contact arm ("catwhisker") found disintegrated by arc after altitude test; replaced by new arm.

10. New HF relay receiver contact arm appeared overheated and contact rivet pressed flush with face; replaced by another new arm prior to oscillograms.

11. Oscillograms and bench tests still show variable reception through relay due to contact uncertainty.

12. Transformer power contacts in one relay stuck closed, arced across small gap in other relay; gaps increased in both relays by contractor's engineer.

13. Both relay bases had ground connections omitted; these were added.

14. 2 mfd condenser was temporarily added across each relay holder coil, to eliminate very excessive sparking at key contacts, prior to oscillograms. May require added resistor.

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Anacostia Comments on GO-2 Equipment (3rd Submission) 8 Dec. 1936.

15. One support screw removed from HF antenna ammeter to eliminate flashover to chassis.

16. IF unit PA capacity switch replaced by another (makeshift) of greater clearance, in attempt to remedy altitude flashover.

17. Altitude flashover finally remedied by changing connections of above switch, placing same in ground side of condensers.

18. IF unit antenna loading coil taps rearranged to remedy flashover into them from adjacent wiring; former cross-over avoided.

19. IF unit antenna selector switch (with hairpin spring fingers) overhauled to reduce sharp corners causing corona at altitude; should be further improved, as some indications of corona remain.

20. Safety gaps removed from both HF and IF antenna bushing, to eliminate premature flashovers at these points.

21. HF unit PA variable condenser plates straightened to eliminate arcing between plates; these had evidently been damaged in handling equipment. Some arcing remained, from P.A. condensers to cabled wiring crowded underneath.

22. HF P.A. tuning switch repaired and overhauled after evident flashover.

23. After altitude corona arcs between HF Ant.Cap.Switch and bottom of relay (numerous points on nuts & lugs), improvised metal shield was interposed between these two units, evidently remedying the trouble. Greater clearance appears desirable, however.

24. HF antenna tuning dial tightened on shaft after becoming loose.

25. Side tone and filament connecting spring terminals adjusted on rectifier (to IF unit), to remedy repeated defective contacts.

26. Altered interlock gate switch adjustments to give more positive operation.

27. Replaced IF antenna leadout insulator by stand-off (makeshift) insulator, to stop breakdowns experienced at this point.

ENCLOSURE (F)
Page 4 of 12 pages.

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Anacostia Comments on GO-2 Equipment (3rd Submission) 8 Dec. 1936.

C. ELECTRICAL CIRCUIT:

1. Antenna shunt capacitors failed on bench in both HF and IF units; more dependable capacitors of higher rating should be used.

2. Excessive reaction of Antenna Loading upon Coupling in IF unit; electrical zero of coupling varies position with tuning, with observed shifts in excess of 60 geometrical degrees, accompanied by variations from as many as 4 different minimum positions down to a single position of minimum coupling effect as dial is rotated. Suggest shielding Ant Load coil.

3. Excessive key contact sparking, should be remedied by condenser and/or resistor absorption circuit.

4. Excessive keying noises during break-in reception. Oscillograms indicate excessive hang-over of oscillation in transmitter after power contact opens and receiver connection restored. Resultant receiver blocking prevents break-in reception above 20 w.p.m. on same frequency, receiving 10 micro-volt signals.

5. Receiver trimming and sensitivity are considerably affected by connection through I.F. antenna loading circuit, and vary throughout tuning range. Under certain service conditions the transmitter antenna circuit has been found to form a trap circuit which rejects up to 99 percent of the received signal strength.

6. Although equipment was found to operate OK with either side of AC supply grounded, the unsymmetrical voltage to ground should be investigated, with a view to possible alteration.

D. DRAWINGS & INSTRUCTION BOOK:

1. Note several errors & changes in schematic diagram supplied.

2. Simplified functional schematic diagrams should be added in Instruction book for ease in understanding circuits.

3. Instruction Book, among others, should discuss following items:
   (a) How to tune fixed antenna around 1/2 wave, and to ascertain antenna emission despite absence of antenna current indication.
   (b) Advise necessity for re-trimming receiver antenna when receiving through IF unit, and keeping attenuation at minimum.
   (c) Detailed instructions for removing both M.O. compartments.

ENCLOSURE (F)
Page 5 of 12 pages.

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E. KEYING RELAY:

1. Receiver antenna contact arm too delicate for service use, and makes unreliable contact; sticks open at times.

2. Holding back coil spring suspension invites failure of pig-tail connections; too flimsy.

3. HF relay has cracked Isolantite block (apparently due to screw pressure); noticeable blackening, apparently from corona.

4. Keying spark suppression necessary.

5. Excessive receiver transients and restoration delay.

6. Pigtails subject to corona failure must be better spaced.

7. Relay base must be dependably grounded to chassis & Ground post.

8. Lock washer adjacent to antenna contact support appears too large.

9. Adjusting wrench should have slot at 15 degree angle.

10. Some adjustments difficult to reach with wrench.

11. Receiver antenna bushing is phenolic instead of ceramic; all receiver RF insulation required to be ceramic, including Rec antenna terminal bushing.

12. Relay covers do not fit readily. Mark front of covers HF and IF relay, respectively, (not rubber stamp) to insure matched fit, if necessary.

13. Sheet rubber washers above relay bases are disintegrating under pressure; believe these are unnecessary and undesirable.

14. Appreciable pitting and uncertainty of contacts has been observed; question contact point material; absence of all wiping action is believed detrimental to self-cleaning & low resistance.

15. Oscillograms indicate some inefficiency in that relay completes its travel without drawing more than about 60% full current, but that full current builds up and persists during key closed period without effecting work.

16. Keying relays not readily removable from transmitter unit; should attach straightforward without undue complications.

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F. SHOCK PROOF MOUNTING:

1. Mounting studs attached to top & bottom of all cases should have sharp edges rounded off, to prevent scoring of surfaces on which they may be laid.

2. Present attachment of rubber mounts complicates installation in service plane by "loseability" of intermediate buffer discs while mounting, and inability to assemble upper mounting plate to its rubber suspension from underneath. Desirable mounting procedure consists in first attaching to airplane all upper and lowermost Lord button assemblies, then securing mounting plates thereto with a minimum of loseable parts. It is suggested that threaded studs be permanently and securely attached to all uppermost & lowermost Lord units, including buffer metal discs. The Lord buttons riveted to the mounting plates should have through holes (not tapped) so that the plates can be slipped in place on the studs, and then secured by means of an elastic stop nut, or equivalent, on each stud, accessible through the mounting plate opening.

3. Question strength of thin sheet metal pieces attached to upper Lord button bases.

4. Upper snap slide connecting handles unnecessary, should be left off.

5. Bottom snap slide connecting handles not securely connected to snap slides; screws & nuts have worked loose. Suggest permanent riveting.

6. Apron handles on bottom snap slide pieces project unnecessarily downward; suggest reducing downward projection from present 1" to new 5/8" dimension for greater ruggedness.

7. Stiffness of mounting plates should not be reduced below present design.

G. RECTIFIER UNIT:

1. Some spring contacts on sides (to trans. unit) were found to give unreliable contact; apparently improper adjustment of contacts, and misalignment of contact carrying plates.

2. Safety interlock switches unreliable and not adequately mounted.

3. Front access plate interlock unreliable and flimsy mounting.

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Anacostia Comments on GO-2 Equipment (3rd Submission) 8 Dec. 1936.

G. RECTIFIER UNIT (Cont'd):

4. Fuse mounting clips should accommodate Navy standard fuses, type NAF- 213010

5. No mountings provided for spare fuses; suggest clips for 4 spare fuses be attached to inside of access cover.

6. Insufficient positioning detent (and apparently excess friction) on HF - IF switch; apparently poor contact.

7. Plugs for side tone cables are recessed in too far, allowing only 1-1/2 threads to engage and leaving excessive play between plug portions, without full engagement. Were not adequately locked or staked in place. Anchor more securely.

8. Power connector plug should have only 4 terminals instead of 6, to facilitate connection and avoid confusion by installation personnel.

9. Threaded nipple on power plug shell loose (not spun tightly) and thread won't fit standard Navy conduit fitting.

10. Painted circuit numbers on side terminal blocks will readily obliterate; suggest engraving.

11. Meters should have white markings against black background.

12. Fil. Voltmeter should have red line at 10.0 volts.

13. Fil.Voltmeter by-pass condenser mounting screws too long, bear against meter housing.

14. 1 mounting screw missing from Plate milliammeter by-pass cond.

15. VS-1 Rectifier tube socket is cracked.

16. Tube guide positioning slots ineffective (not high enough) and are confused with spring slots.

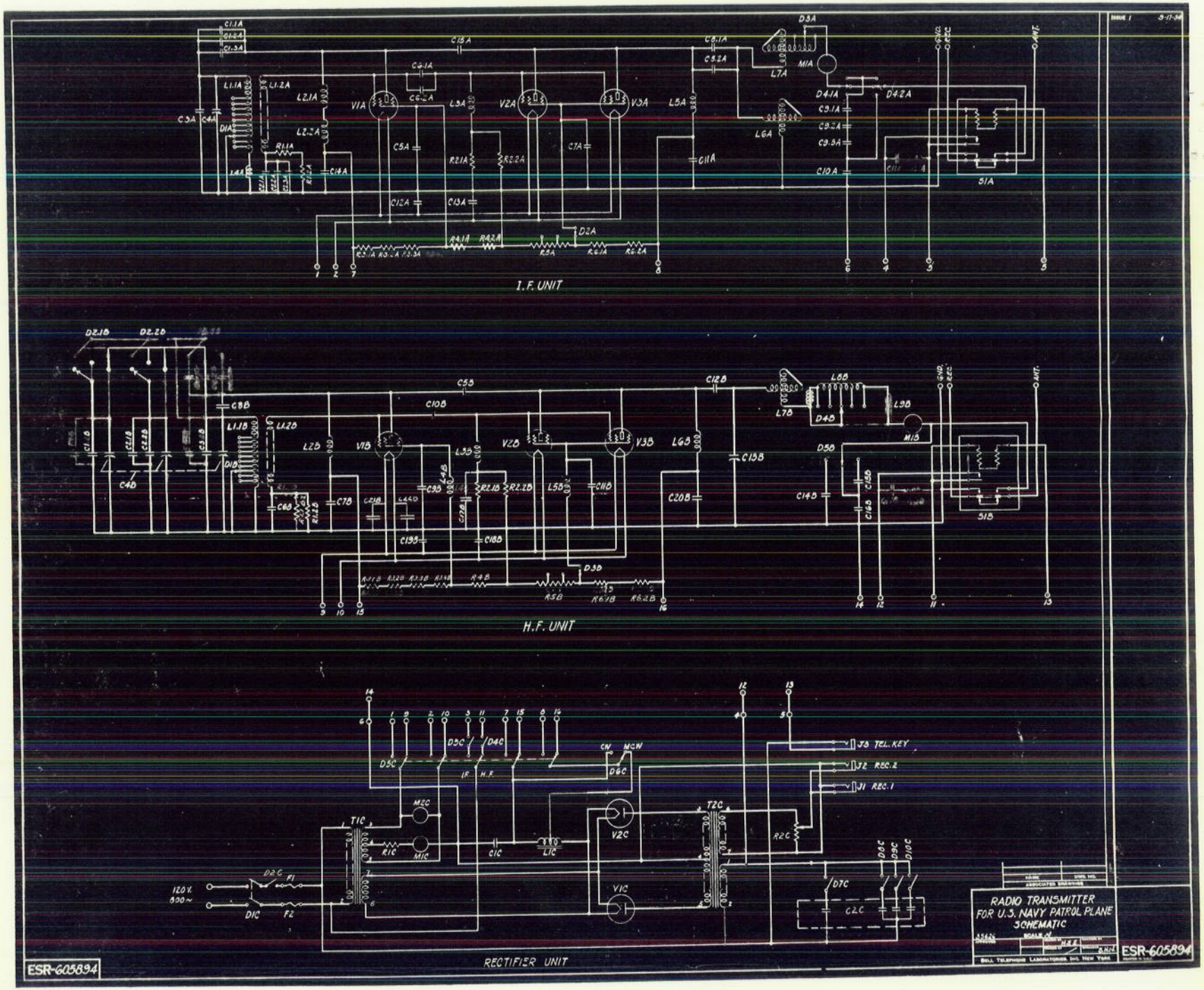
17. Compensating capacitor switches and Side tone resistor are loose in single hole mounts; not properly secured.

H. TRANSMITTER UNITS (both):

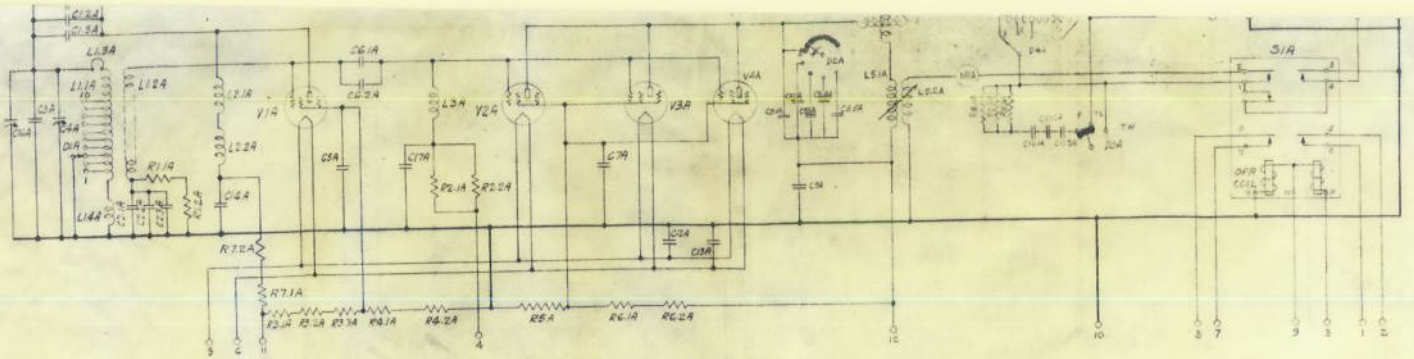
1. Cases are too high for units to slide in or fit properly; when sliding units into cases, top pieces foul against reinforcing strips around cut-away portion, and when forced over these the sets hang from the top rather than rest on

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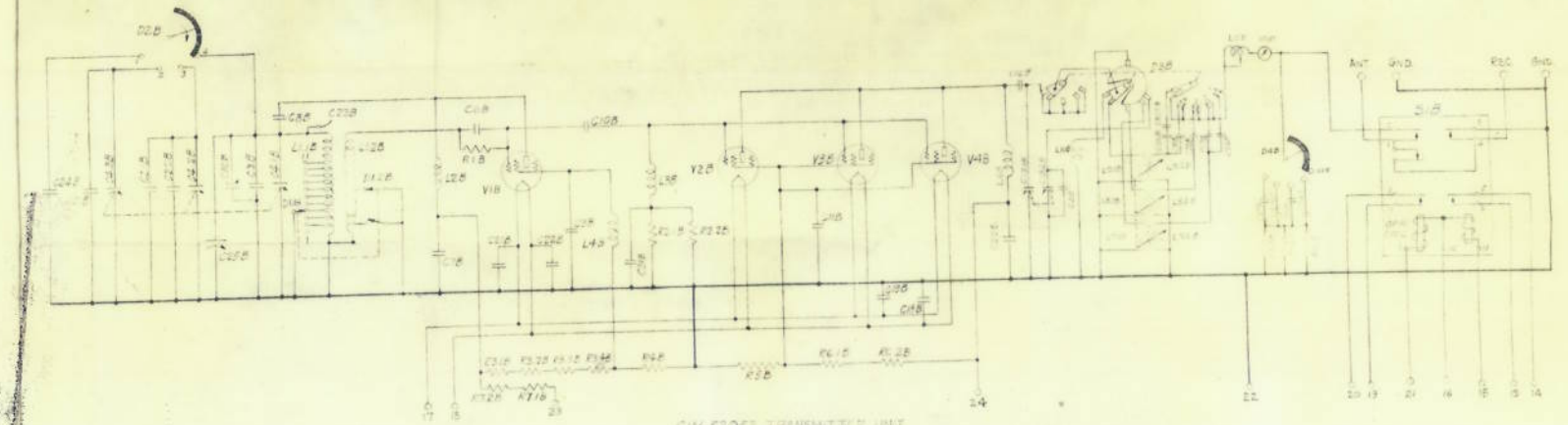
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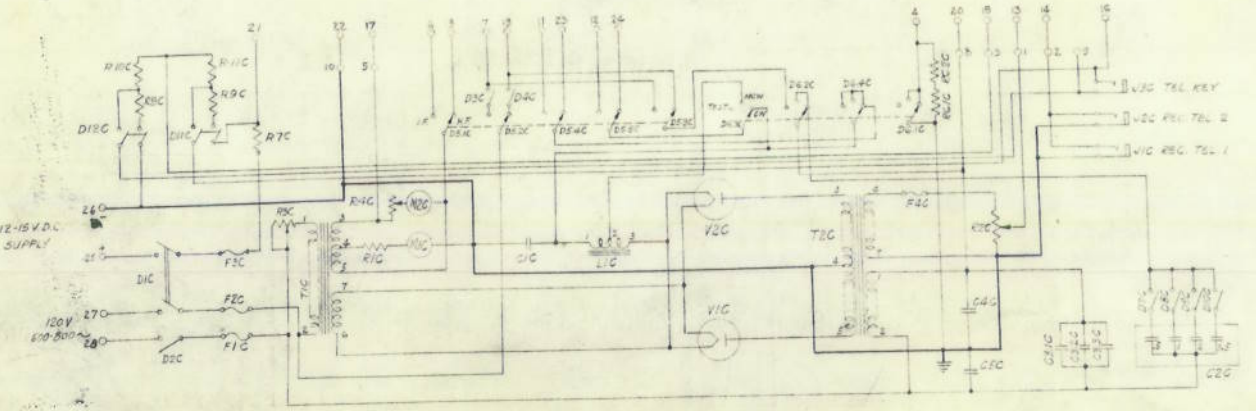
Enclosure H



CW-52054 TRANSMITTER UNIT
INTERMEDIATE FREQUENCY



CW-52053 TRANSMITTER UNIT
HIGH FREQUENCY



CW-20042 RECTIFIER UNIT

GO-2 RADIO TRANSMITTING EQUIPMENT FOR U.S. NAVY PATROL PLANE
SCHEMATIC

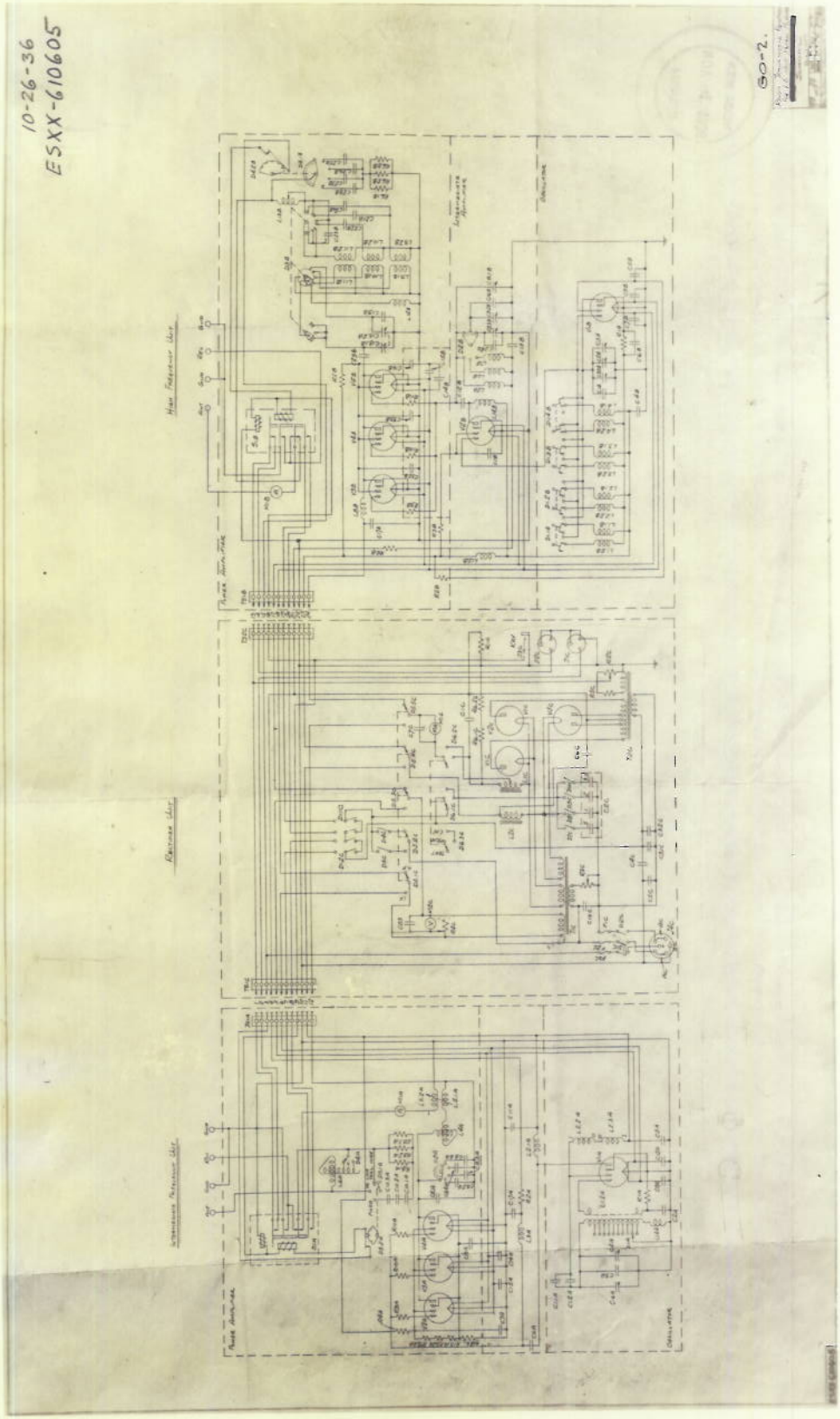
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Enclosure I

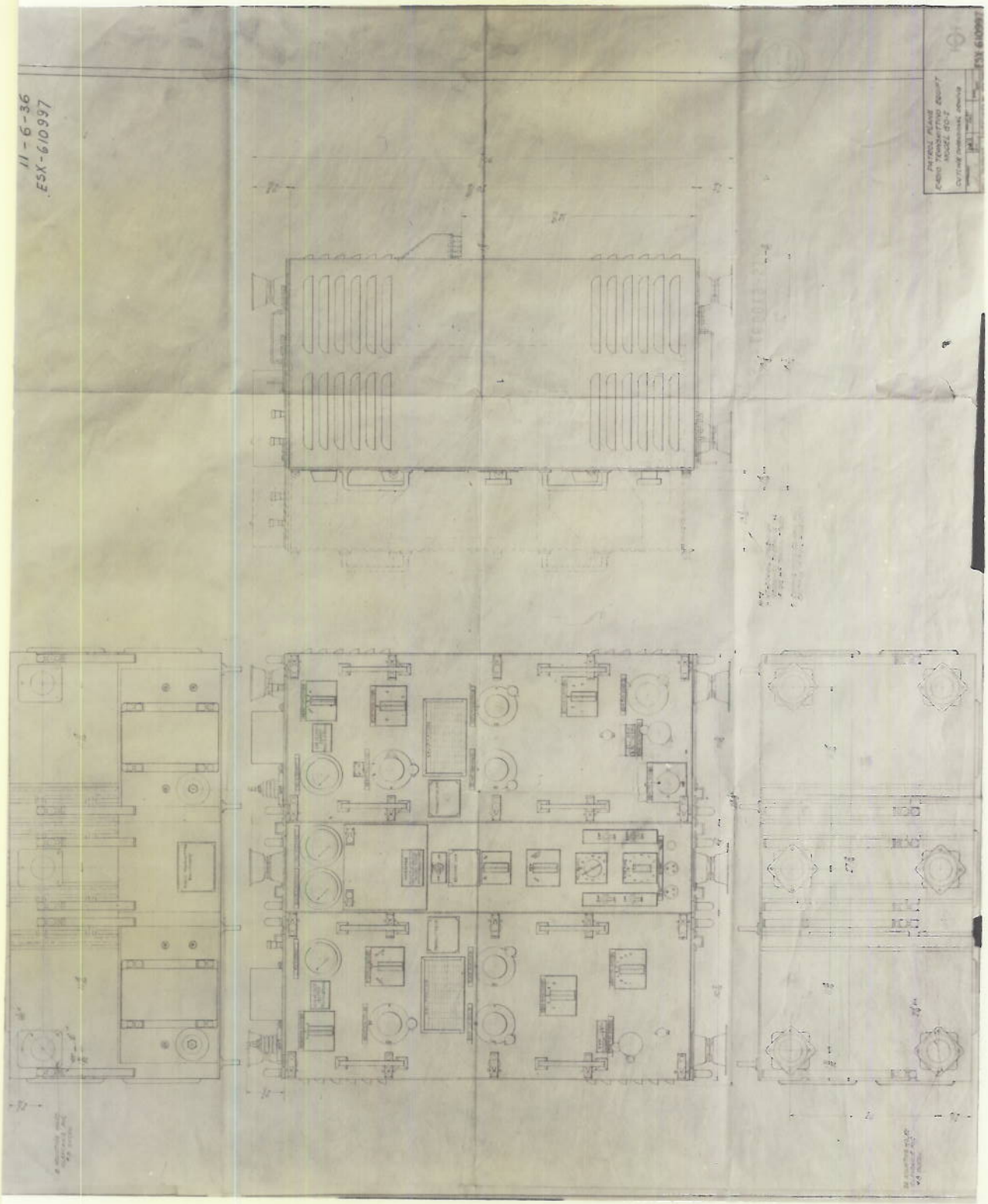
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ESXX-610605



Enclosure J

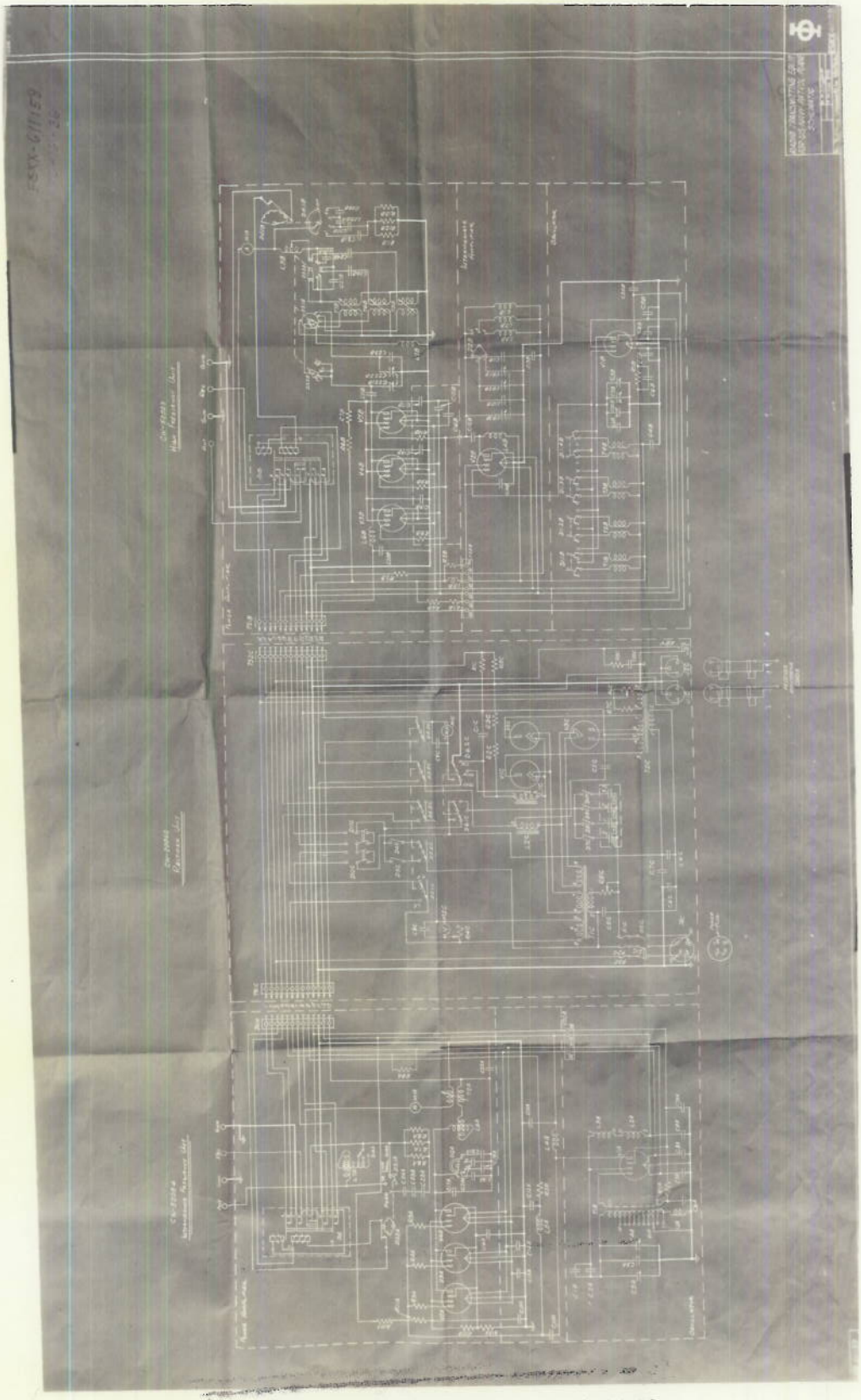
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ESX-610997



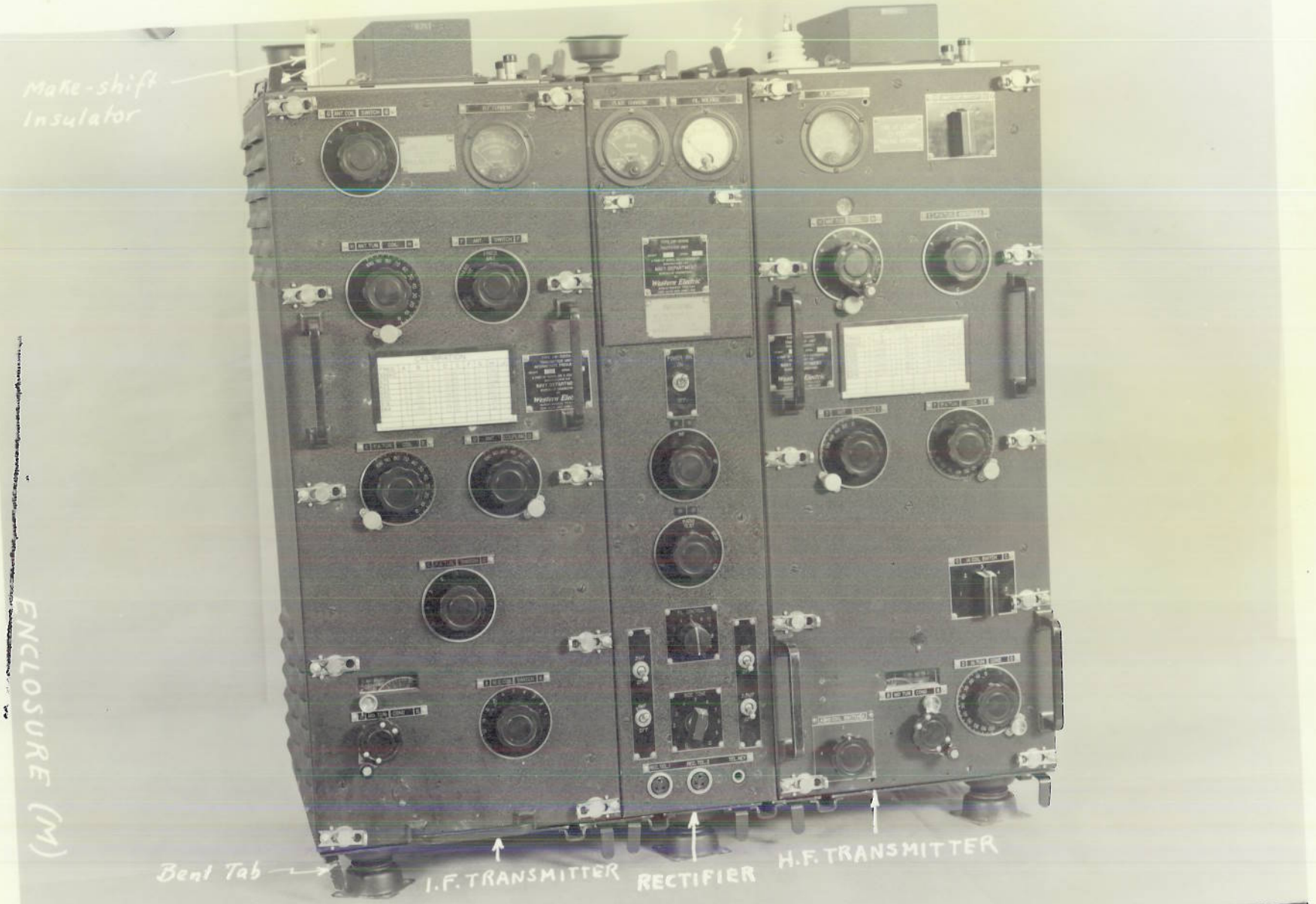
Enclosure K

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Enclosure 1



Final sample GO-2 radio equipment; front view of complete assembly less cables

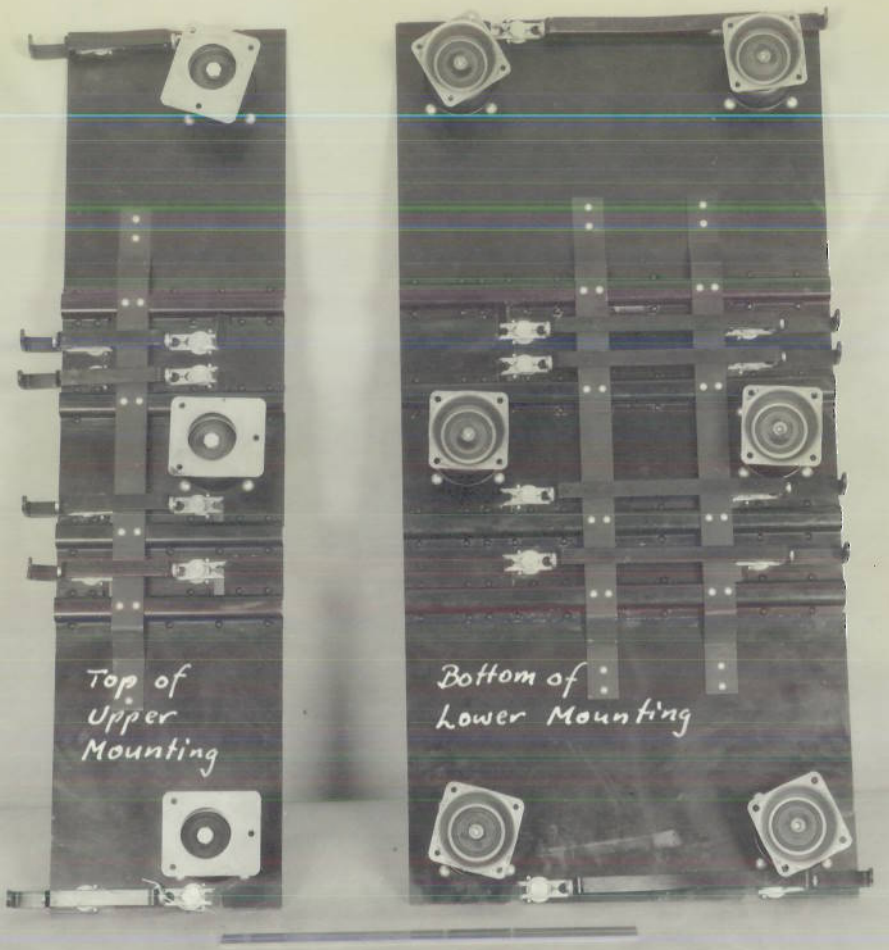
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ENCLOSURE (M)

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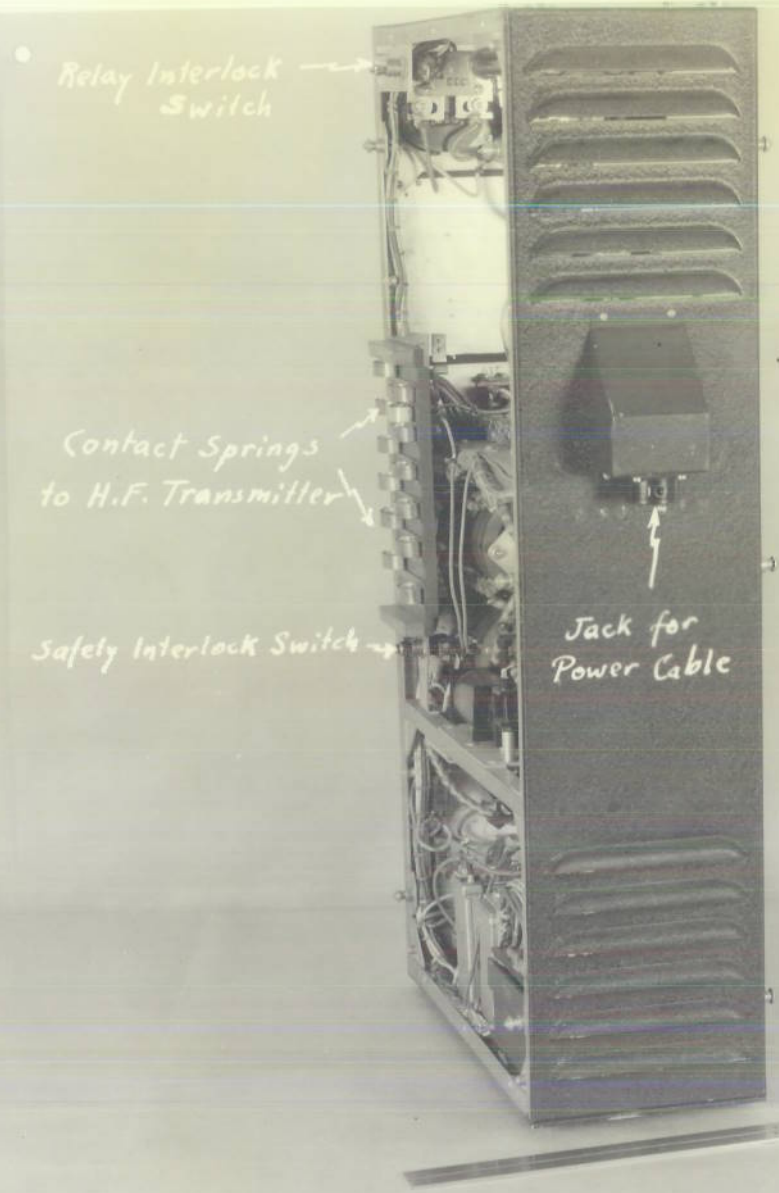
ENCLOSURE (N)



Final sample GO-2 radio equipment. Upper and lower mounting plates.

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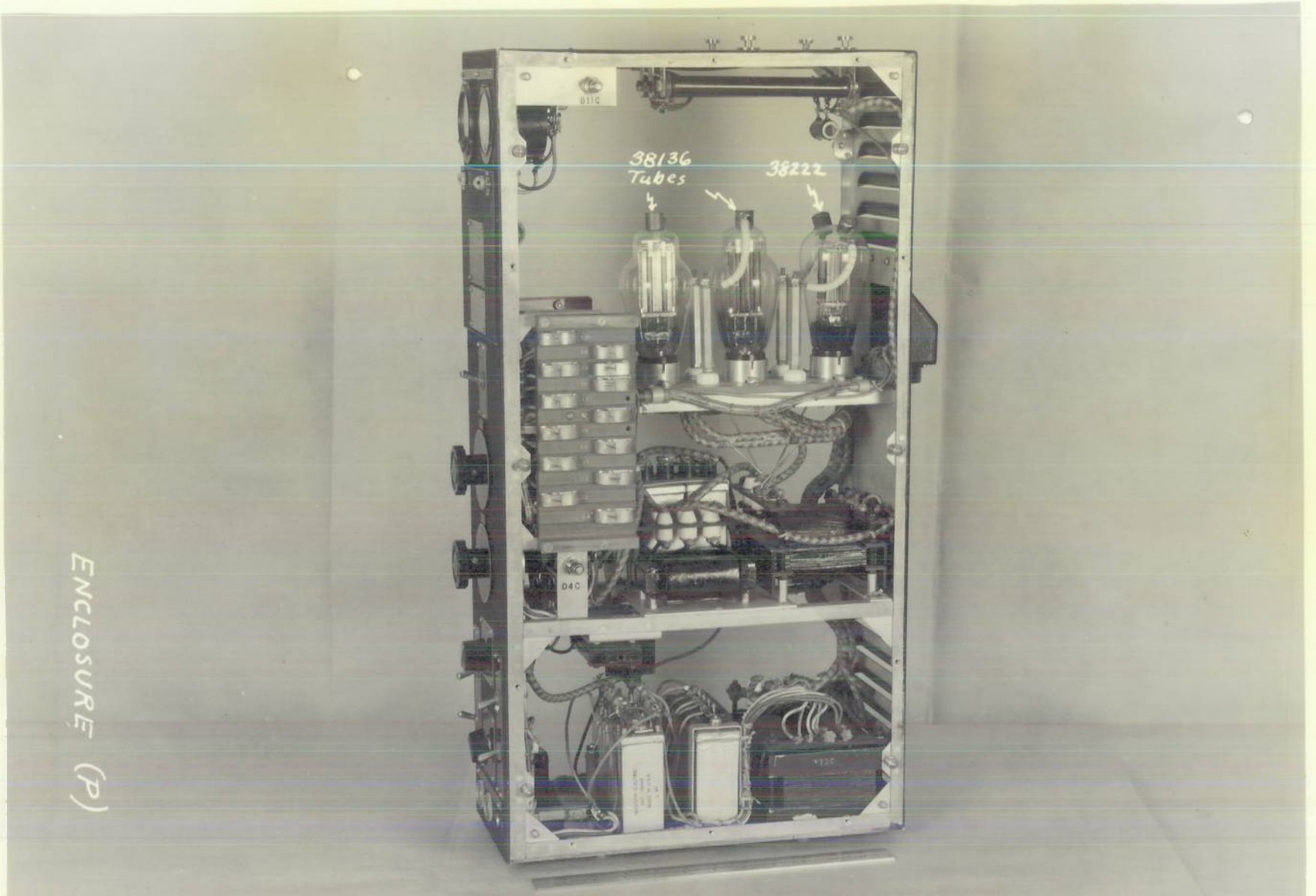
Final sample GO-2 radio equipment. Rear view of rectifier unit.

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ENCLOSURE (O)

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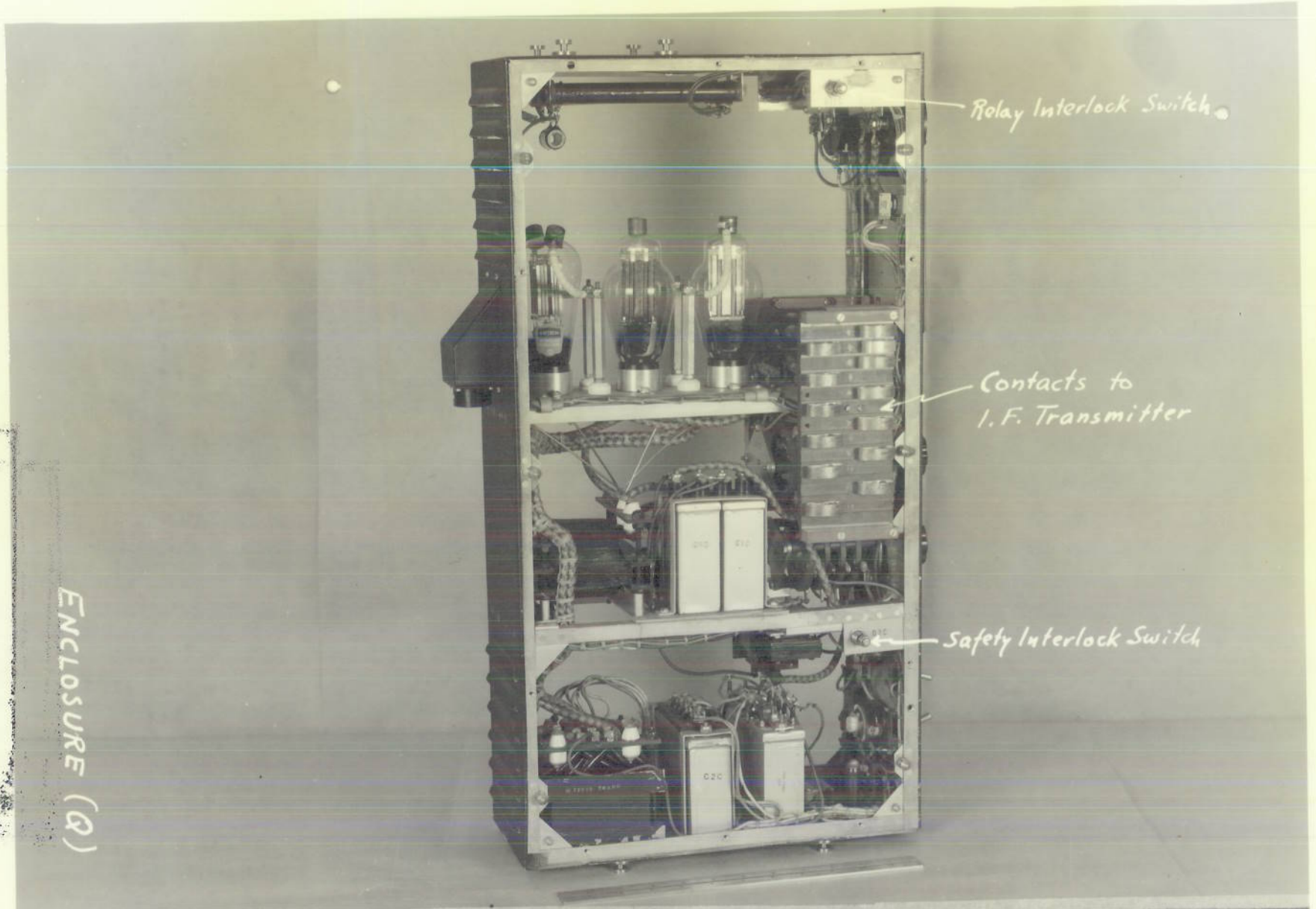
Final sample CO-2 radio equipment. Right side view of rectifier unit.

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ENCLOSURE (P)

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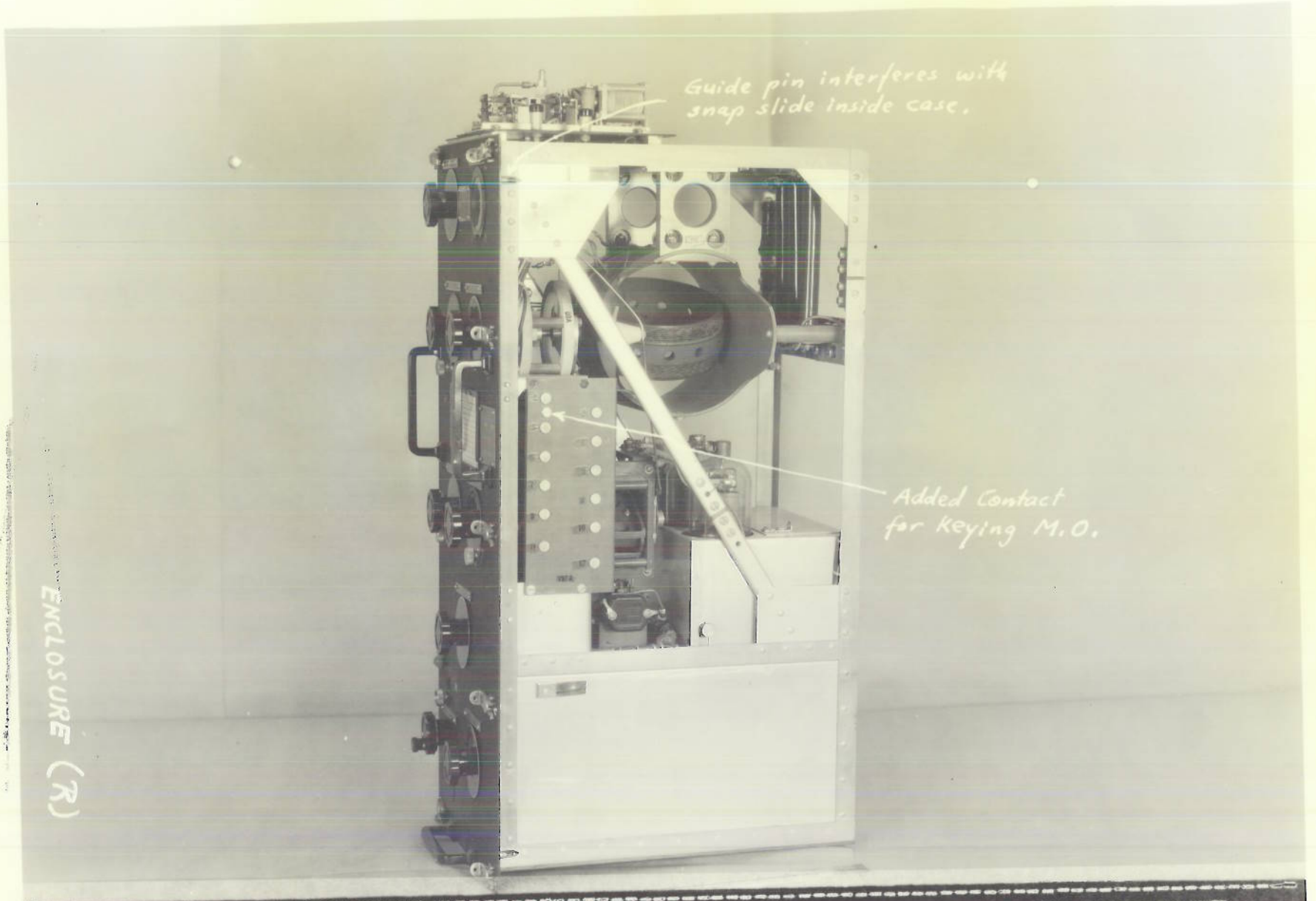
ENCLOSURE (Q)

Final sample GO-2 radio equip- AN-50057 3-15-37
ment. Left side view of rectifier unit.

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ENCLOSURE (R)



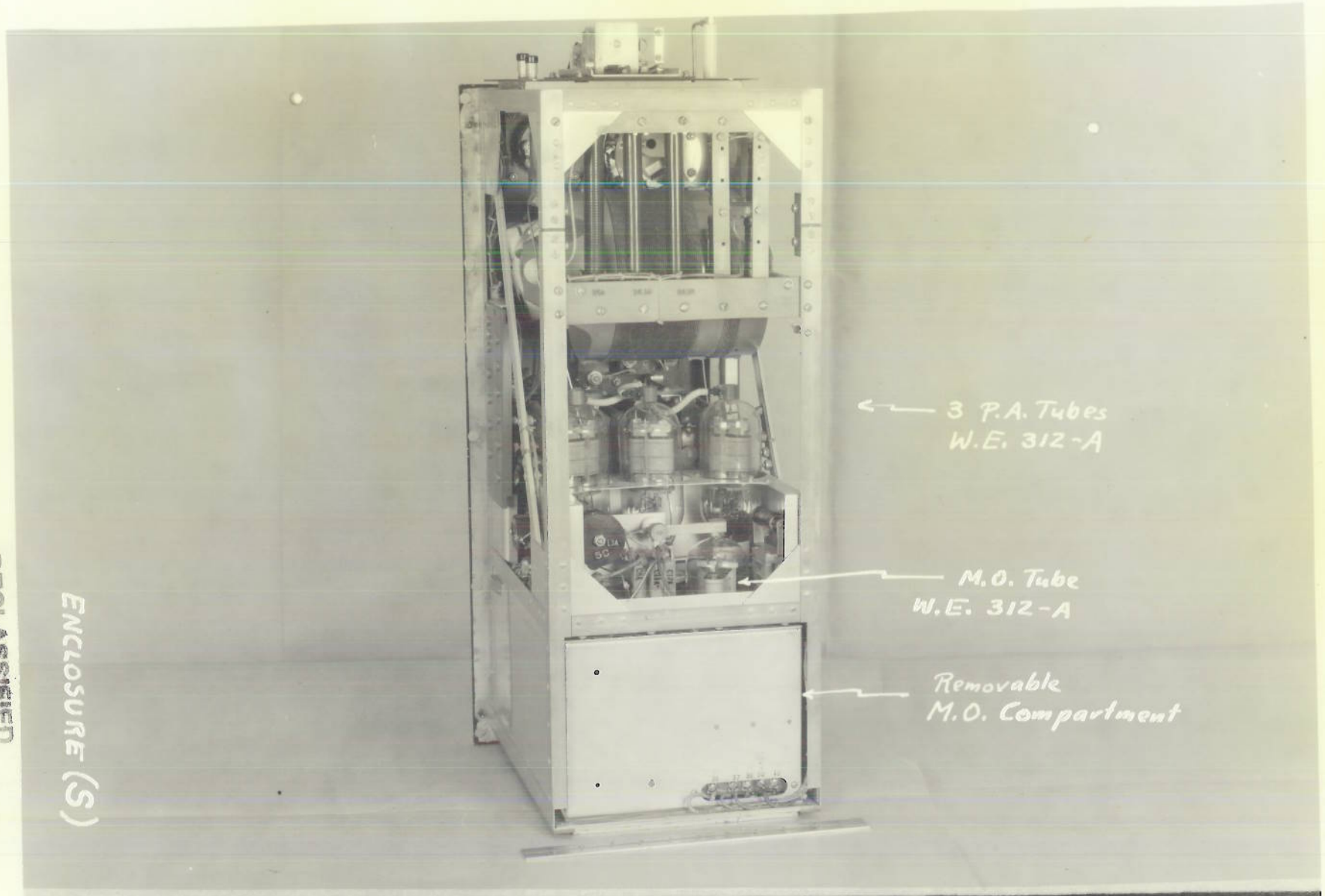
Final sample GO-2 radio equipment. Right side view of intermediate-frequency unit without case.

AN-50058 3-15-37

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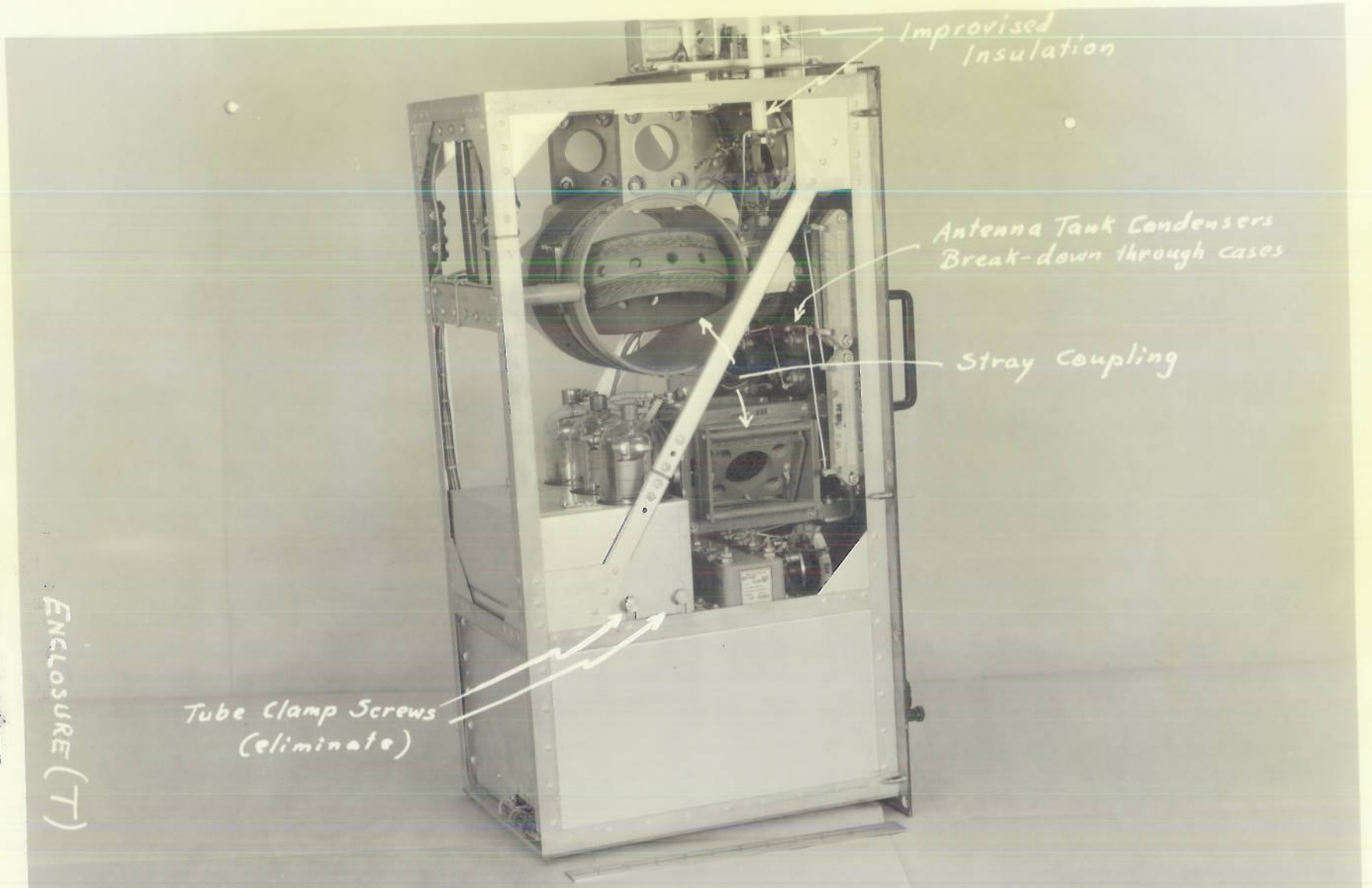
ENCLOSURE (S)



Final sample GO-2 radio equipment. Rear view of intermediate-frequency unit without case.

AN-50059 3-15-37

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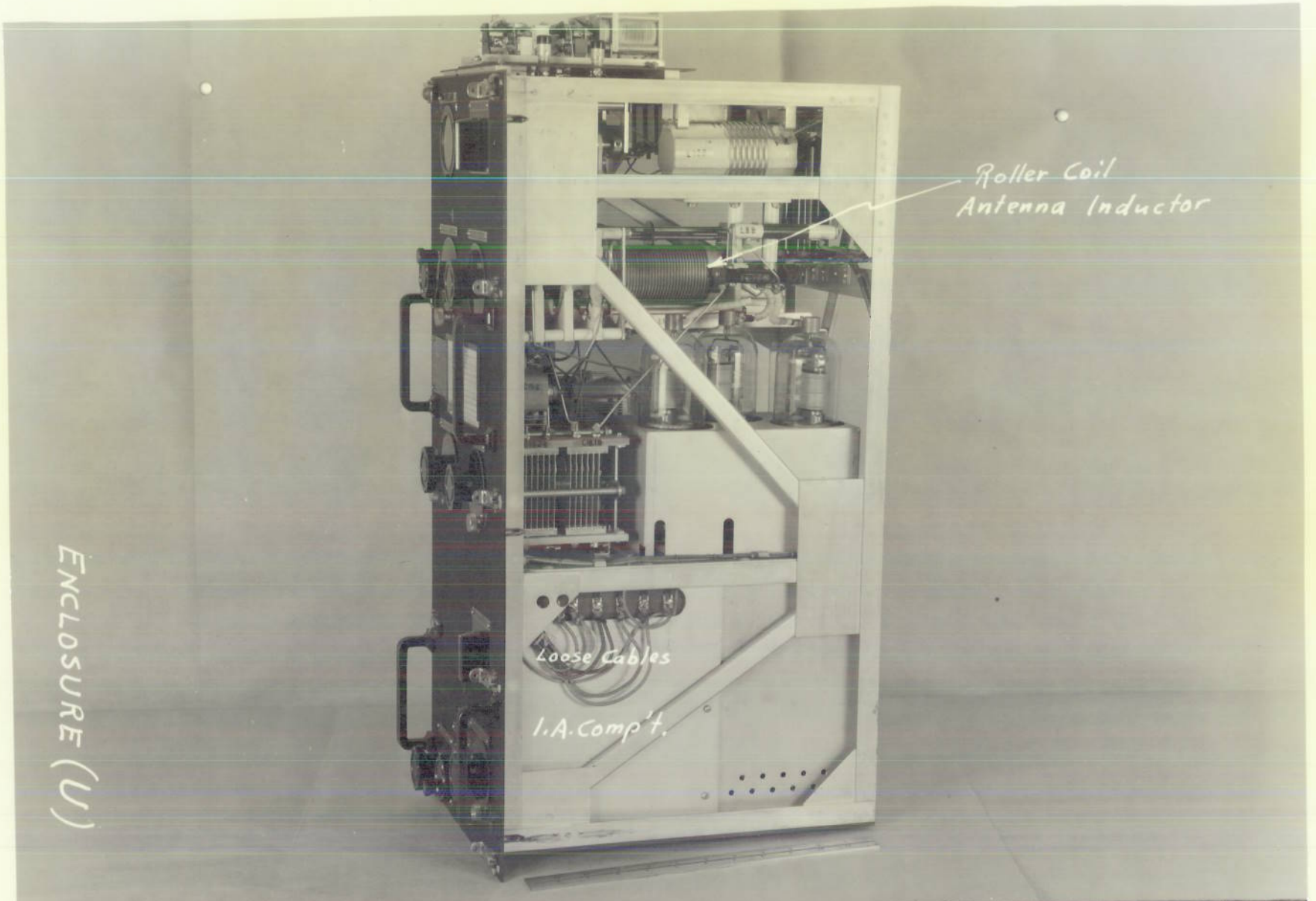
Final sample GO-2 radio equipment. Left side view of intermediate-frequency unit without case.

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ENCLOSURE (T)

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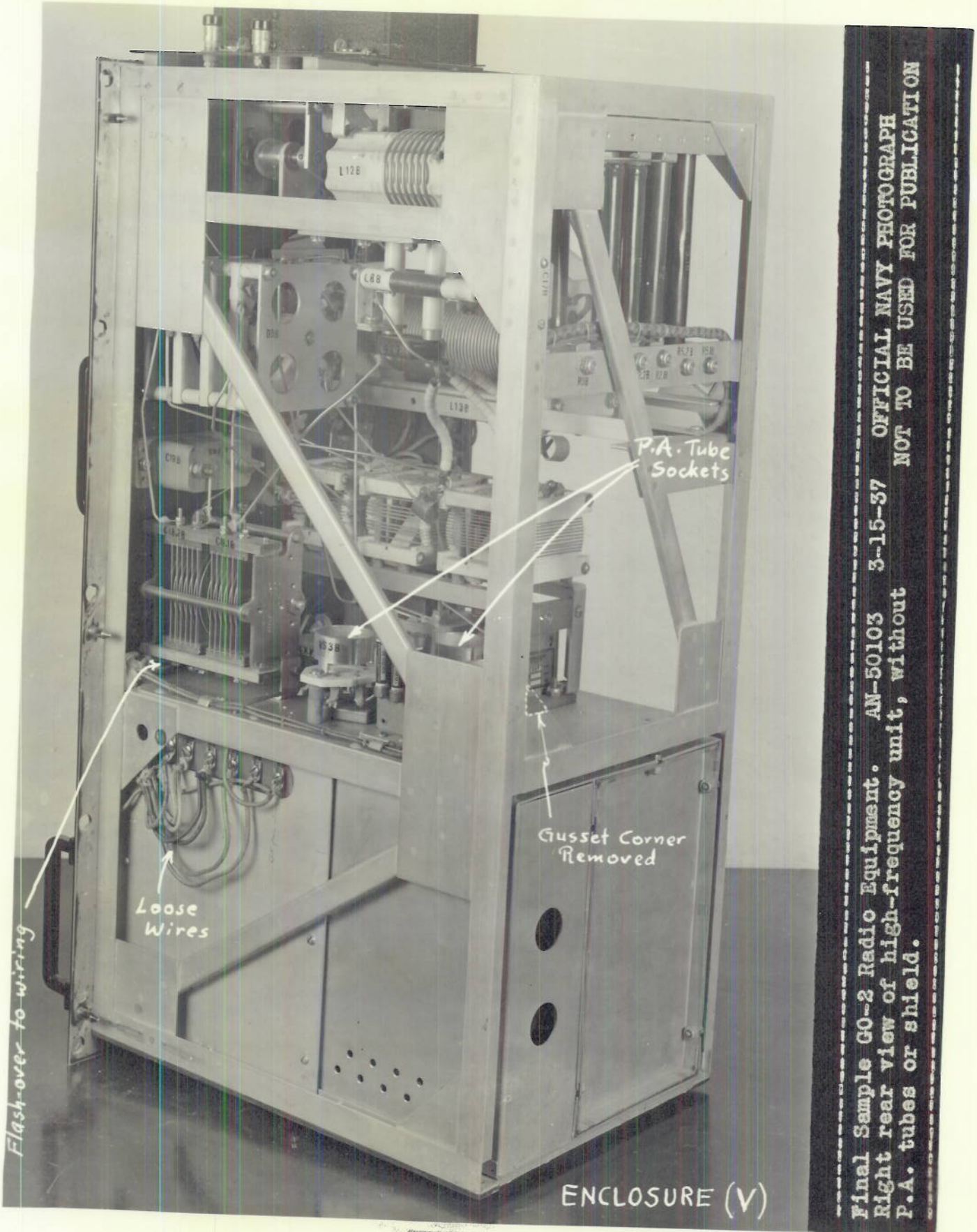


ENCLOSURE (U)

Final sample GO-2 radio equipment. Right side view of high-frequency unit without case.

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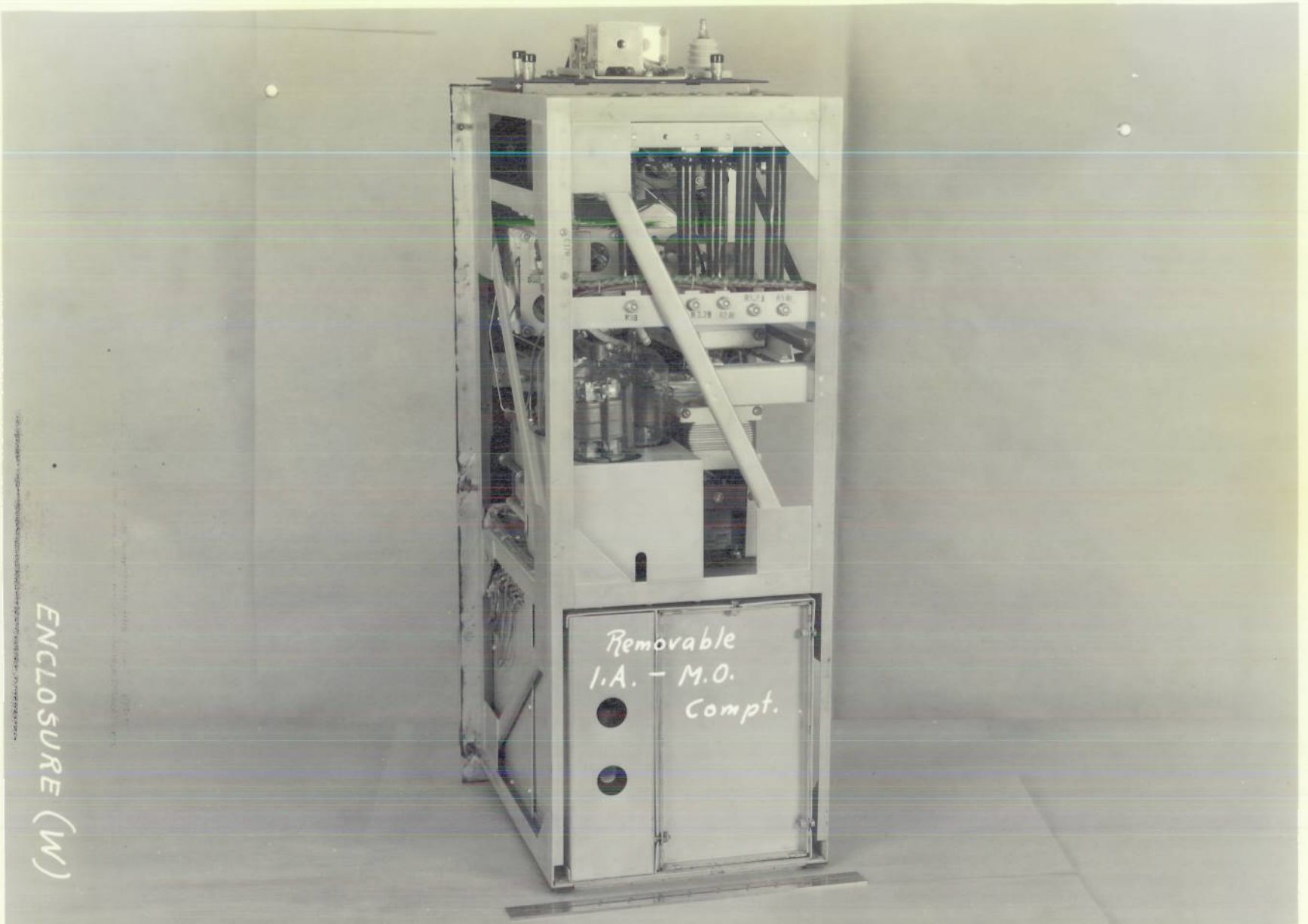
Final Sample CO-2 Radio Equipment. AN-50103 3-15-37 OFFICIAL NAVY PHOTOGRAPH
Right rear view of high-frequency unit, without P.A. tubes or shield. NOT TO BE USED FOR PUBLICATION

ENCLOSURE (V)

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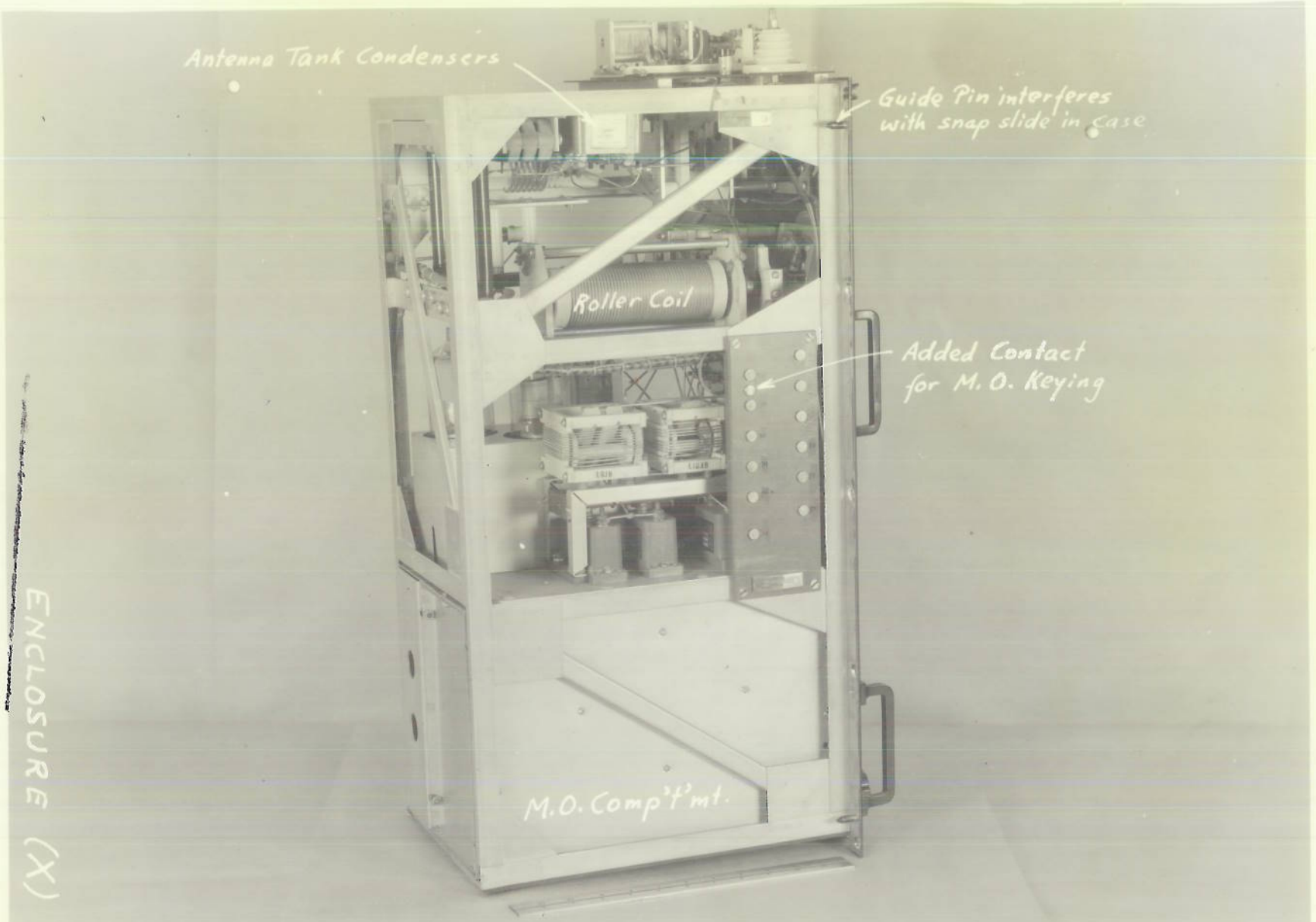
ENCLOSURE (W)



Final sample GO-2 radio equipment. Rear view of high-frequency unit without case.

AN-50063 3-15-37

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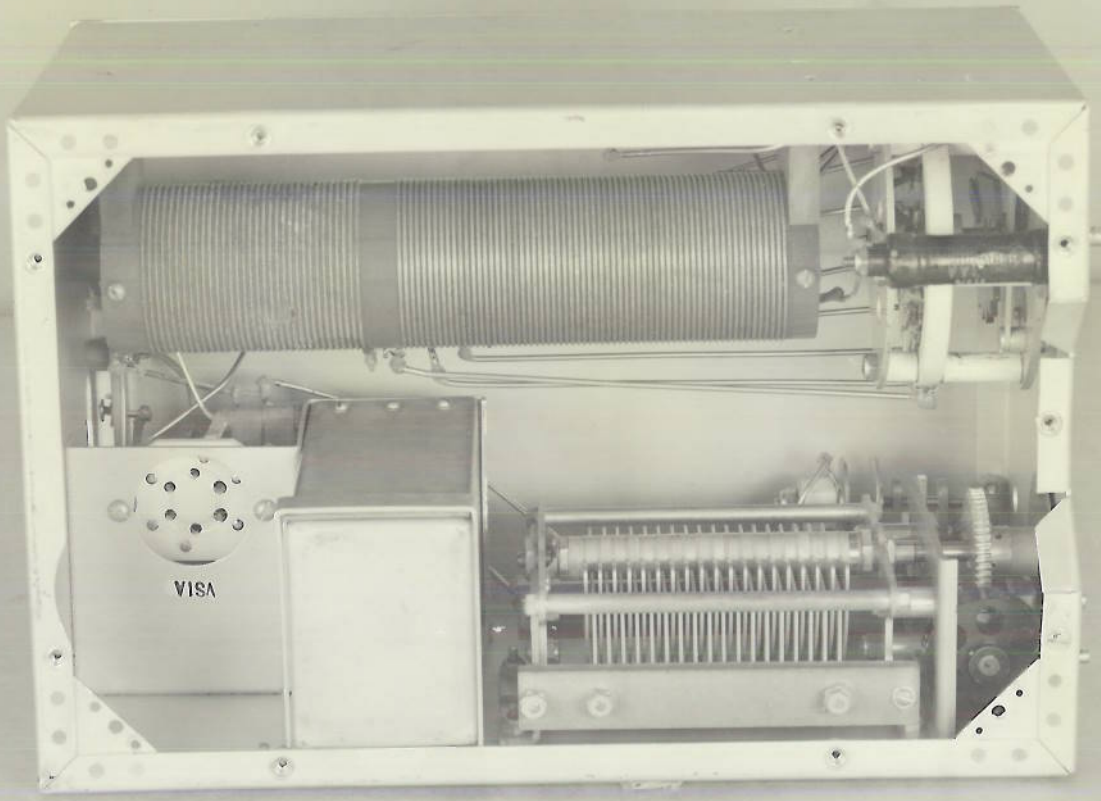
Final sample GO-2 radio equipment. Left side view of high-frequency unit without case.

AN-50064 3-15-37

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ENCLOSURE (X)

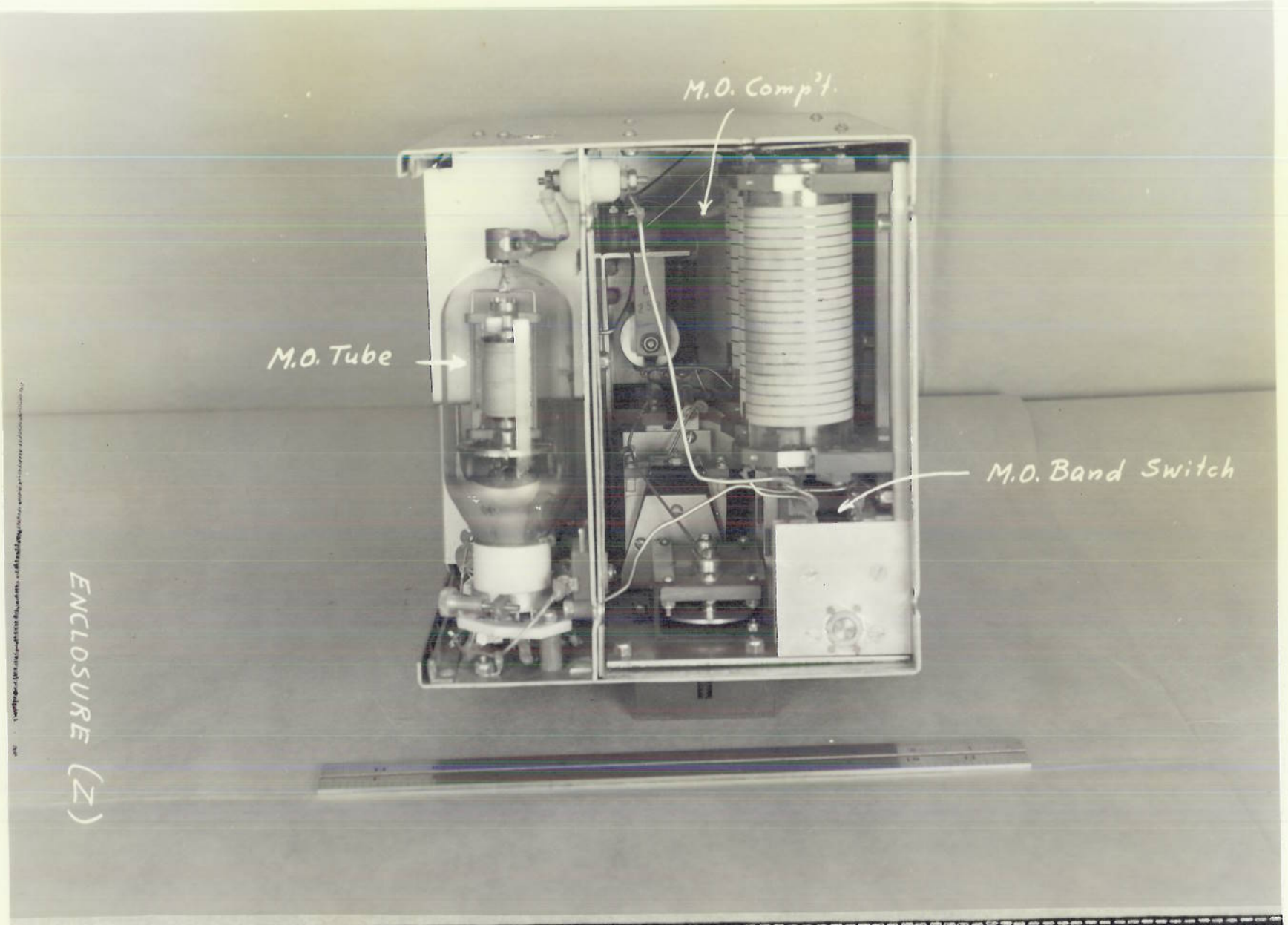
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ENCLOSURE (Y)

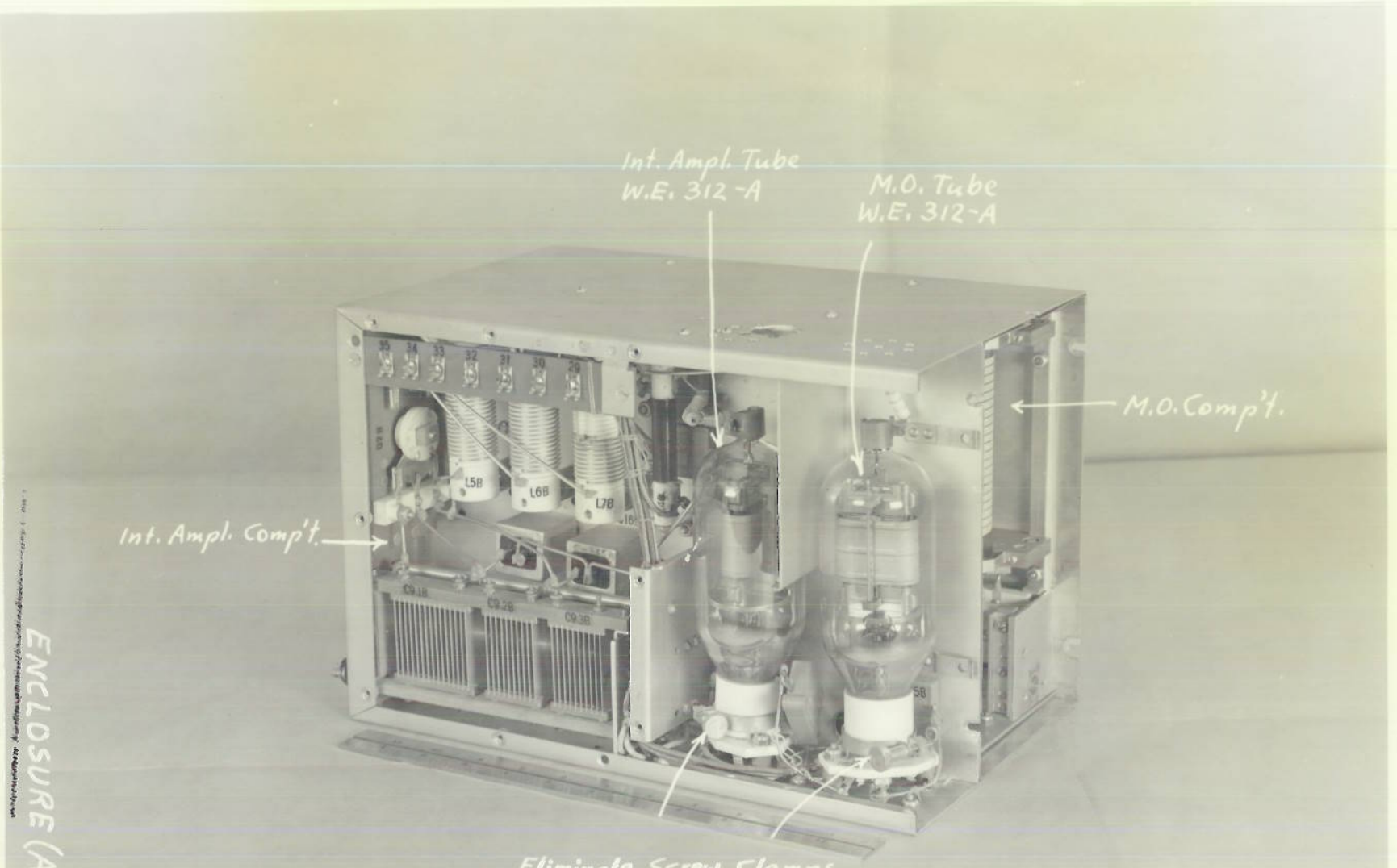
Final sample GO-2 radio equipment. AN-50065 3-15-37 OFFICIAL NAVY PHOTOGRAPH
Top view into M.O. compartment, removed from I.F. unit. NOT TO BE USED FOR PUBLICATION



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ENCLOSURE (2)

Final sample GO-2 radio equipment. AN-50066 3-15-37 OFFICIAL NAVY PHOTOGRAPH
Rear view into M.O. compartment, removed from H.F. unit. NOT TO BE USED FOR PUBLICATION



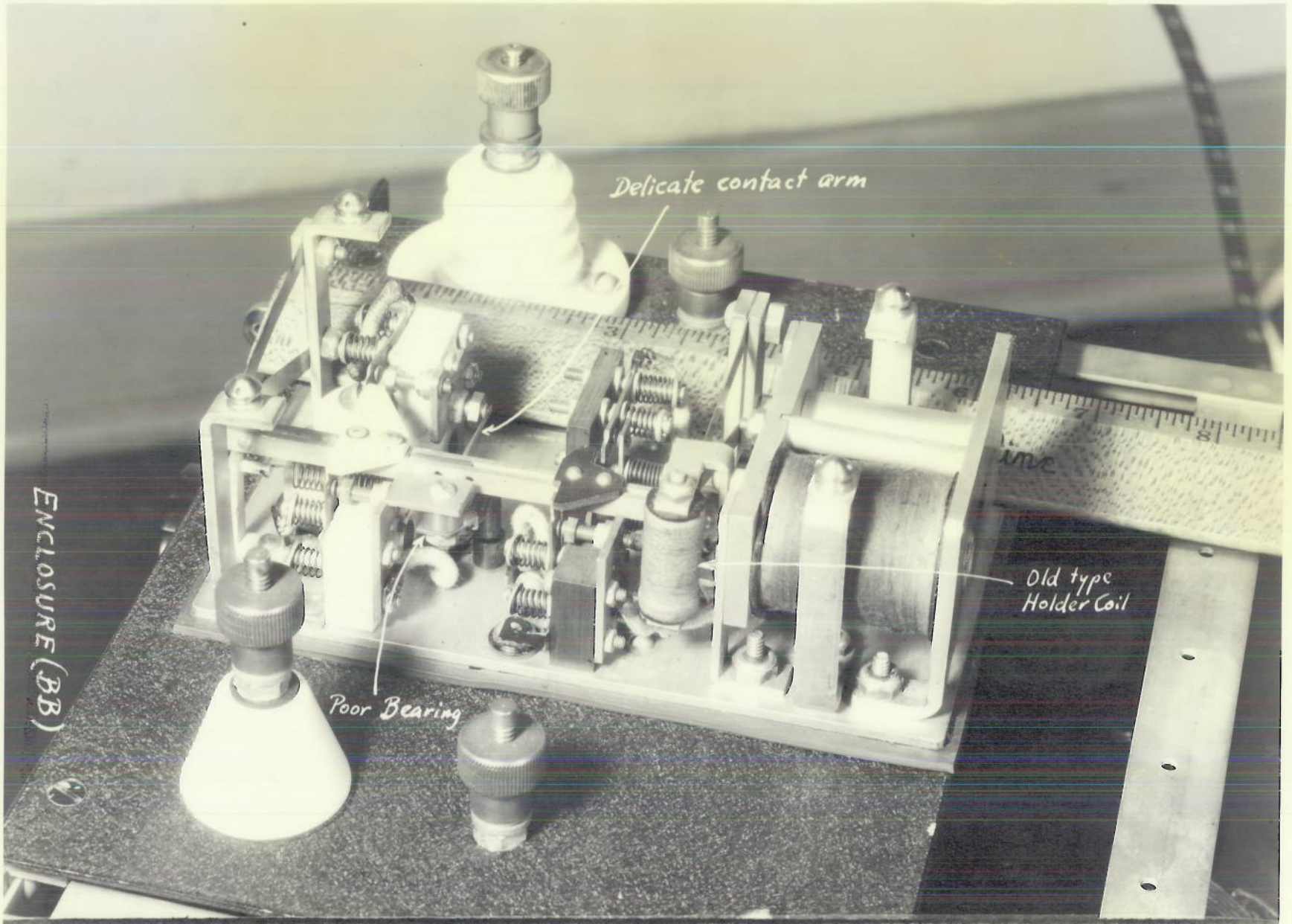
Final sample GO-2 radio equipment. AN-50067 3-15-37 OFFICIAL NAVY PHOTOGRAPH
Left side view into intermediate amplifier NOT TO BE USED FOR PUBLICATION.
compartment, removed from H.F. unit.

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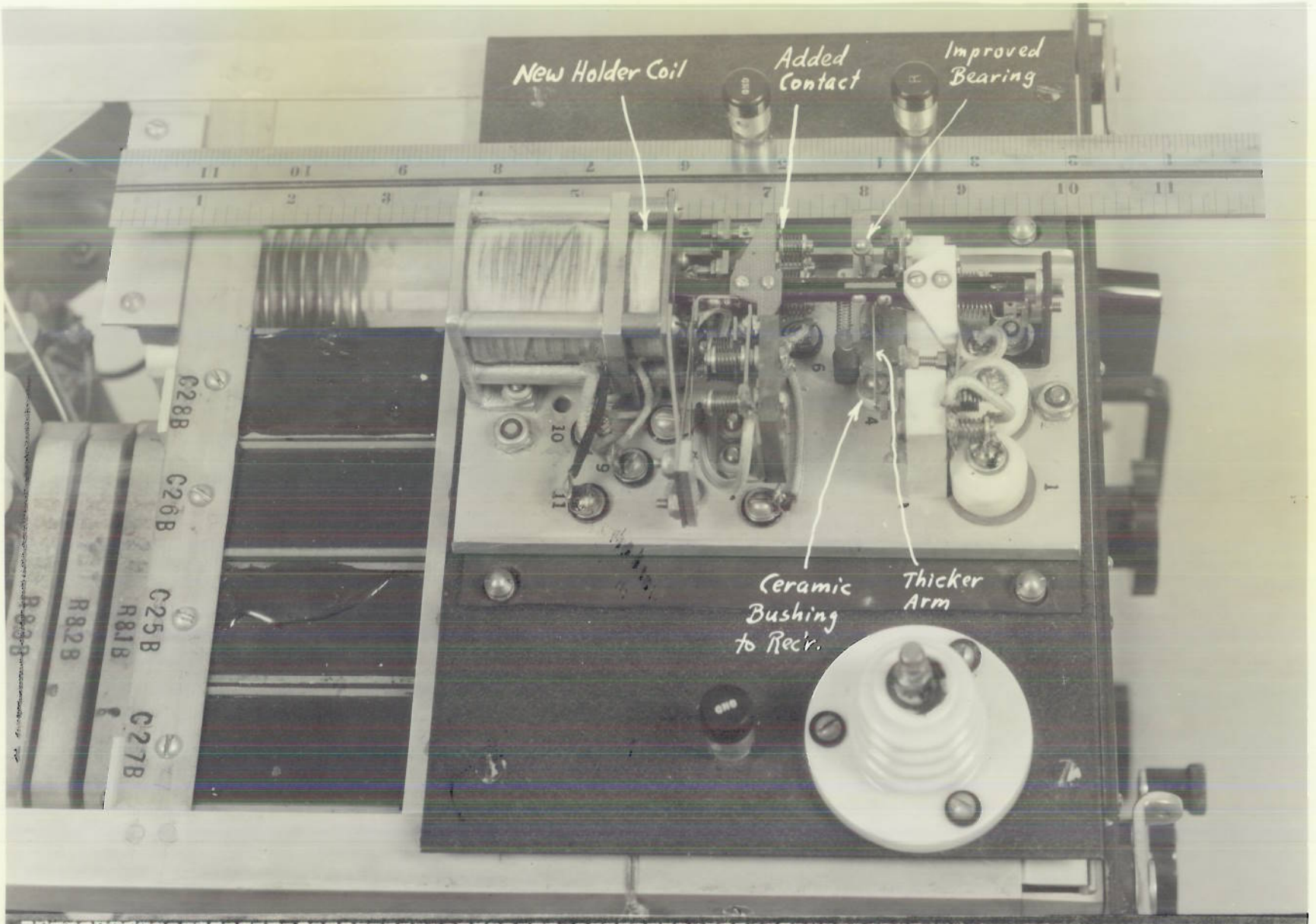
ENCLOSURE (AA)

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ENCLOSURE (BB)



Second sample CO-1 radio equipment. AN-34384 7-3-36 OFFICIAL NAVY PHOTOGRAPH
Detail view of keying relay on I.F. unit, without cover. NOT TO BE USED FOR PUBLICATION



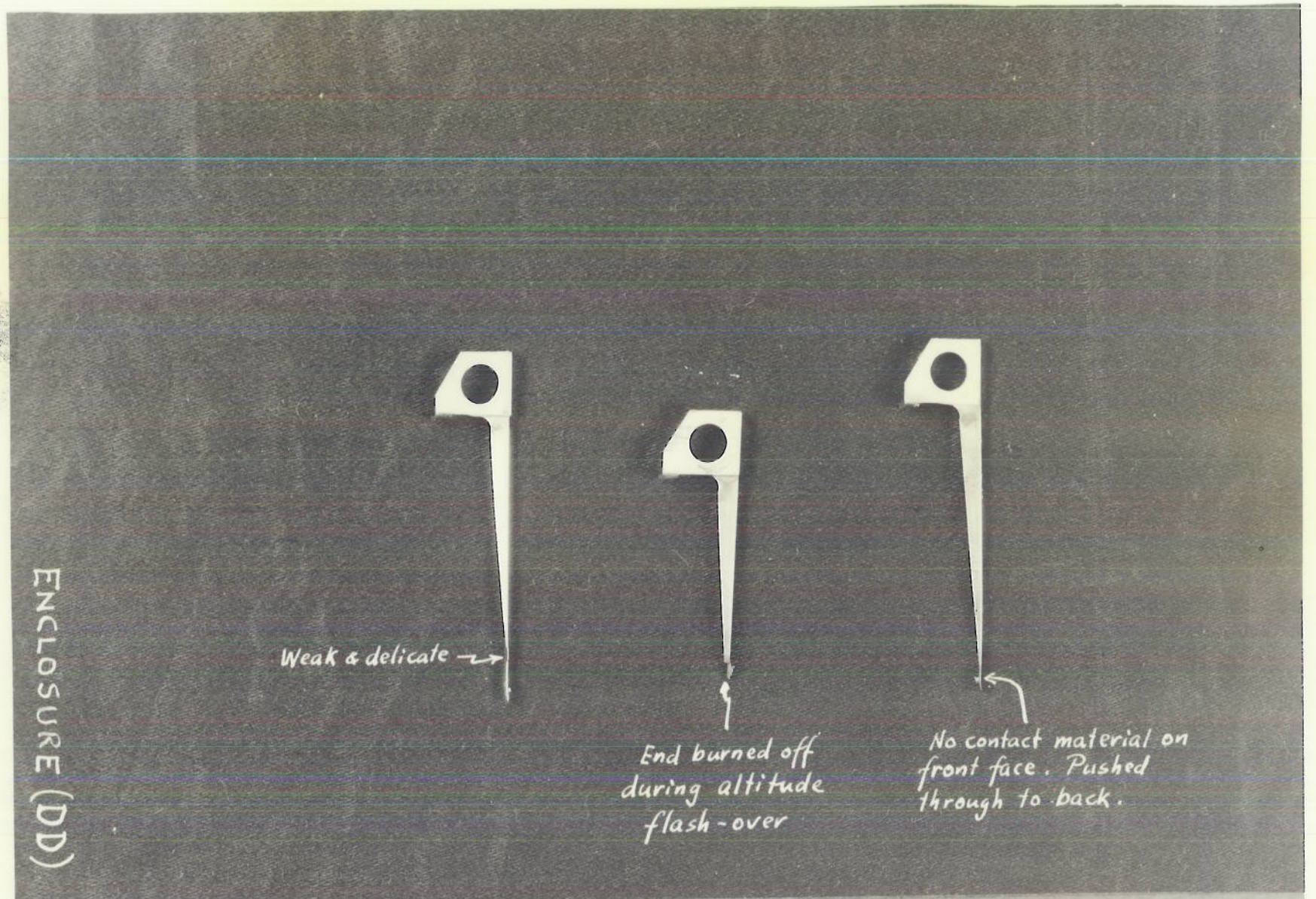
Final sample GO-2 radio equipment. AN-50068 3-15-37 OFFICIAL NAVY PHOTOGRAPH
Detail view of improved keying relay on H.F. unit, NOT TO BE USED FOR PUBLICATION
without cover.

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Enclosure (cc)

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ENCLOSURE (DD)



Second sample GO-1 radio equipment. AN-50069 12-3-36
Defective receiver antenna contact arms from keying relays.

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION

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Enclosure (E)



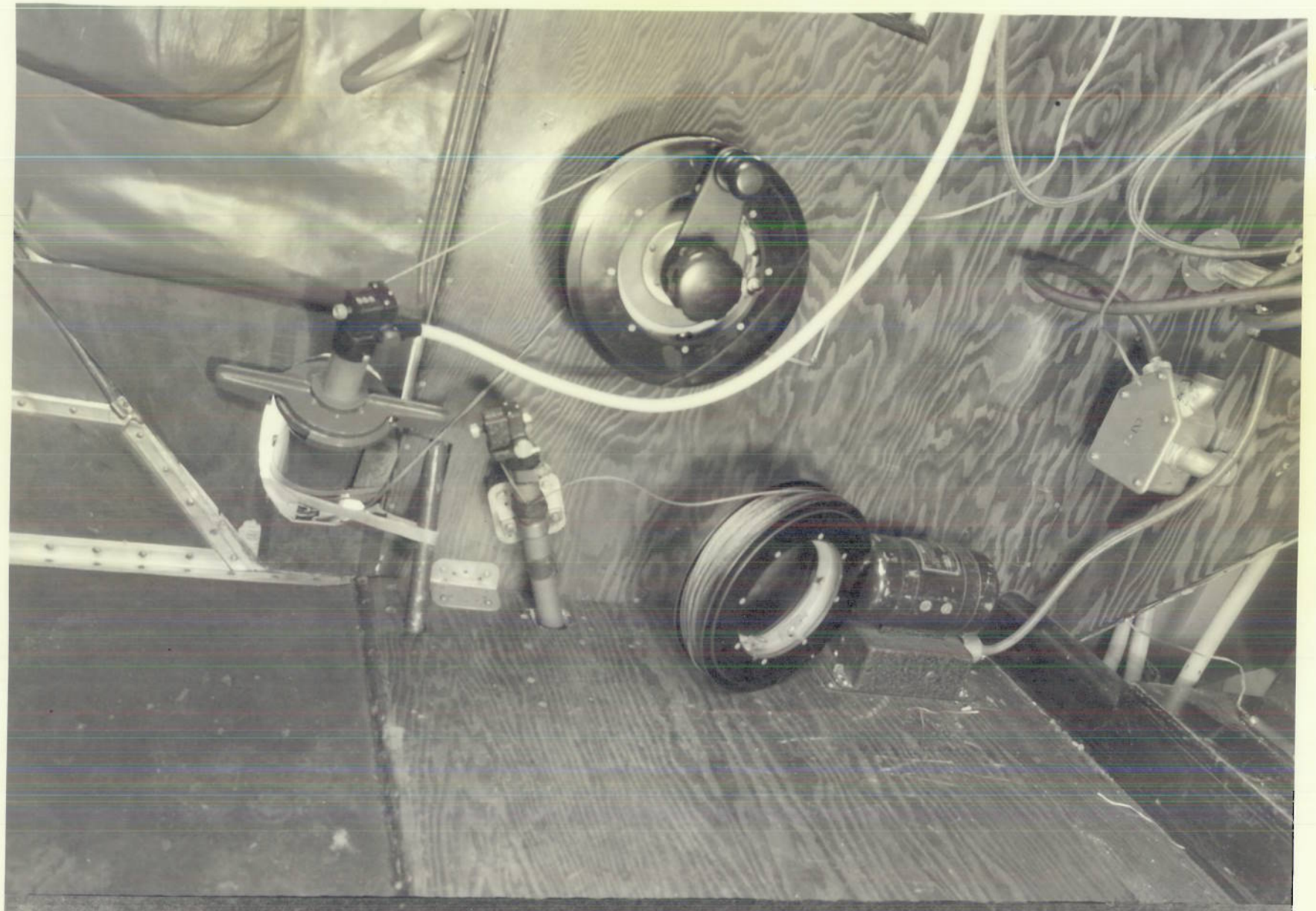
Three Fingered Fixed Antenna and Patrol Plane Fairlead on XRE-2 Airplane for Tests of GO-2 Equipment.

AN-34762 12-7-36

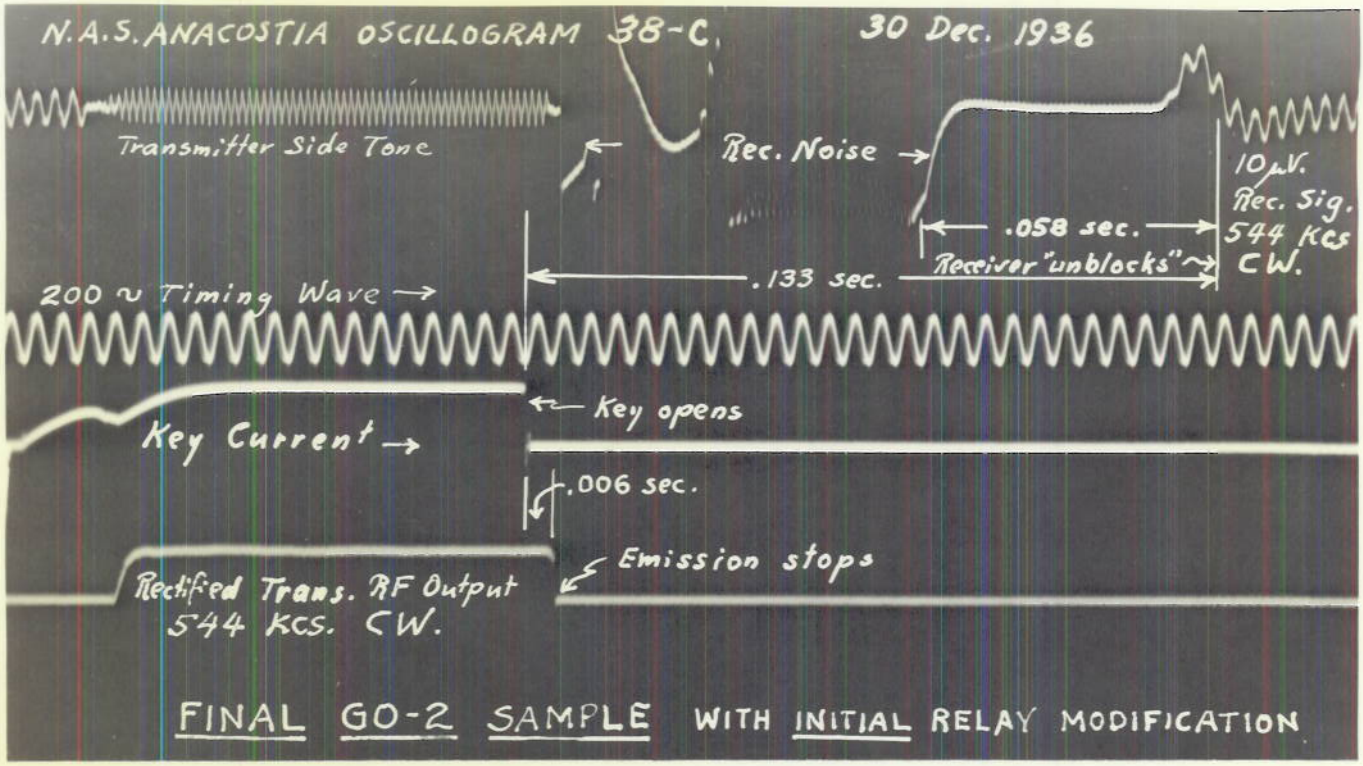
OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION

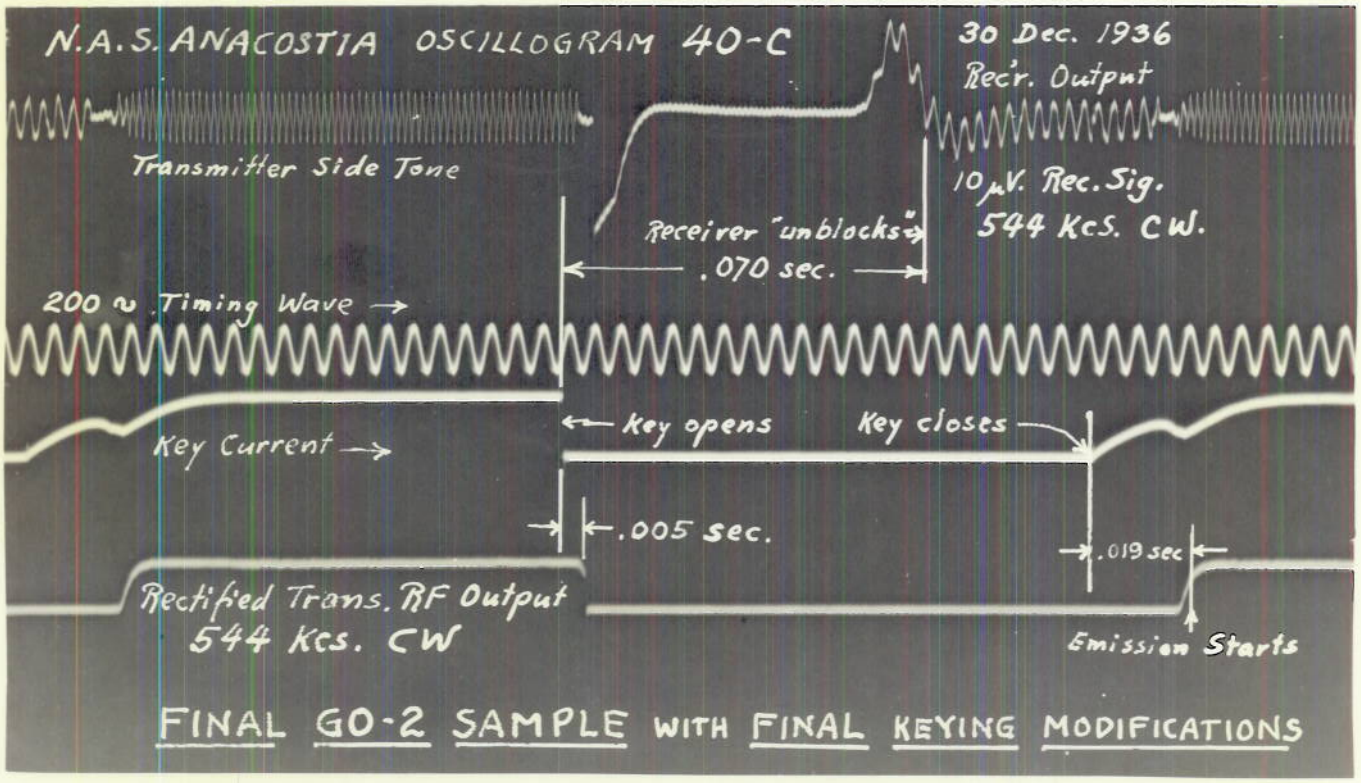
DECLASSIFIED

Enclosure (FF)



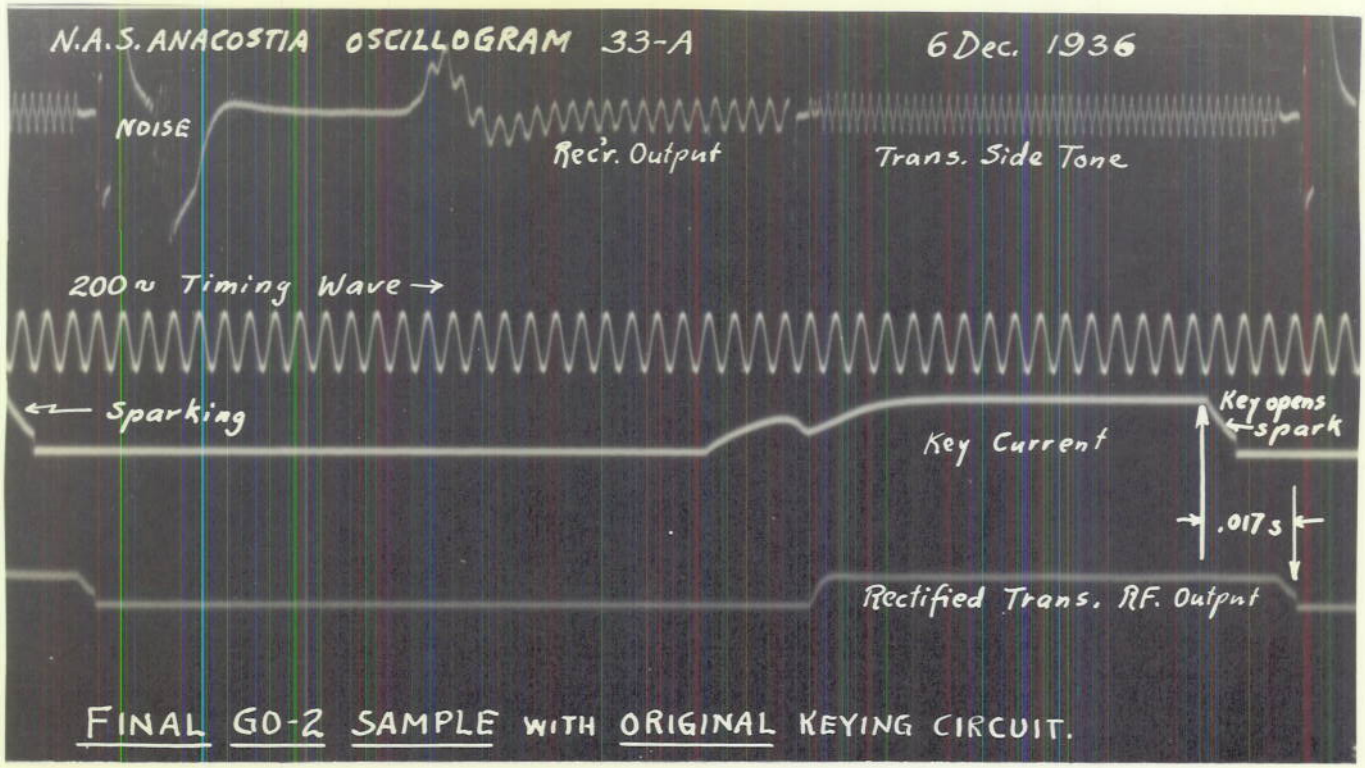
Antenna Reel and Fairlead Mounting in XRE-2 Airplane for GO-2 Equipment. AN-34763 12-7-36 OFFICIAL NAVY PHOTOGRAPH NOT TO BE USED FOR PUBLICATION

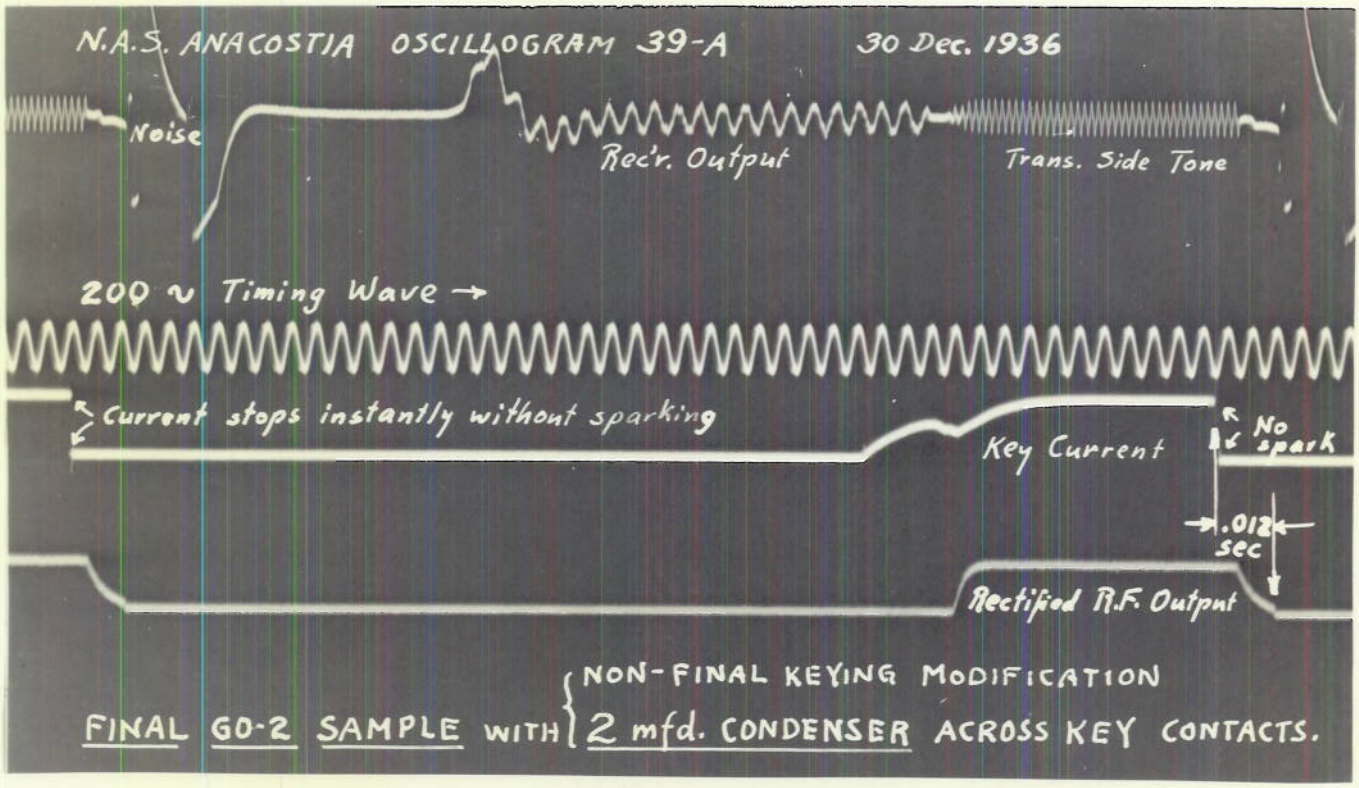




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Enclosure (GC)





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Enclosure (HH)

GO-2 TRANSMITTER TEST DATA

INTERMEDIATE-FREQ. UNIT, FINAL MODEL SUBMISSION

Generator: Type NEA-2
Emission: CW unless otherwise stated
Dates of Tests: November - December, 1936.

1 Line No.	2 Log p.	3 Date	4 Object of Test	5 Freq. Kcs.	6 Antenna ft.	7 Antenna Ohms	8 R.F. Ant. Curr. Amps	9 R.F. Interm. Meter Amps	10 R.F. Output Watts	11 P.A. Plate Curr. M.A.	12 Compensat. Cond. mfd.	13 M.O. Coil "A"	14 M.O. Condenser "B"	15 P.A. Switch "C"	16 Ant. Coupling "D"	17 P.A. Tuning "E"	18 Antenna Switch "F"	19 Antenna Load "G"	20 Antenna Tune "H"	21 "D" for Min. Couple	22 Alternate Min. Couple	23 Remarks
1	104	12/1	Full Power Coupling	300	Fixt	25.6	1.2	1.8	37	225	1.0				2		Fixed	1	43	"-60"		Fil. Volts at ¼ Power 10.6v.
2	"	"	Quarter " "	"	"	"	.6	1.0	9.2	90	0				"-50"		"	"	"	"		Only Coupling Posn. is off scale.
3	"	"	Full " "	"	430'	10	2.5	2.9	62	225	1.0				14		Trail	2	84	"-20"		Fil. Volts at ¼ Power, 10.6 v.
4	"	"	Quarter " "	"	"		1.75	1.9		100	0				"-4"		"	"	"	"		
5	80	11/18	Antenna Tuning	350	485'			3.7		225	1.0	2	2327	2	22	28	Trail	3	98			Compens. Cap. for MCW 1.5mf.
6	82	11/19	Altitude Drift	"	490'	8	3.6	3.8	104	"	1.0	2	2320	2	21.5	27	"	3	95			Troubles with Keying Relay
7	88	11/21	Altitude Breakdown	"	460'			3.0		"	1.5	2	2327	2	32	27	"	3	100			Flash-over, esp. on MCW
8	98	11/27	" "	"	475'			3.8		"	1.0	2	2327	2	37	28	"	"	"			Flash-over at 19,000 ft.
9	102	11/30	" "	"	425'			2.2		"	1.0	2	2327	2	48	27	"	1	100			CW & MCW O.K. 17,500 ft.
10	111	12/7	Transmission Line	"	Resist.	355	0.5		89	130					"120"		T.L.			25		Bench Test with "Zircon"
11	"	"	" "	"	"	600	.255		39	80					"120"		"			40		" " " G.R. Phantom
12	80	11/18	Antenna Tuning	544	485'			2.7		225	1.0	9	910	5	62	33	Trail	2	23			Same Comp. Cap. for MCW
13	"	"	" "	"	150'	43	4.4	4.6	76	"	1.0	"	"	"	26	"	"	3	17			
14	88	11/21	Altitude Breakdown	"	460'			2.8		"	1.5	"	"	"	56	35	"	2	28			MCW flash-over when "G" wrong
15	"	"	" "	"	150'			4.2		"	1.5	"	"	"			"	3	17			" " " in safety gap
16	"	"	" "	"	Fixt.	2.8		3.5	34	"	1.5	"	"	"			"	3	52			CW & MCW Flash-over
17	98	11/27	" "	"	494'			2.5		"	1.0	"	"	"	67	36	"	2	21			Compens. Cap for MCW 1.5
18	"	"	" "	"	175'			4.0		"	1.0	"	"	"	42	"	"	3	75			MCW Flash-over 19,000 ft.
19	"	"	" "	"	150'			4.3		"	1.0	"	"	"	44	34	"	2	86			CW & MCW flash-over 19000'
20	102	11/30	" "	"	Fixt	2.8	3.6	4.4	36	"	1.5	9	917	5	17	43	"	1	52			MCW Corona at 14,000 ft.
21	"	"	" "	"	150'			4.2		220	1.5						"		86			CW & MCW O.K. 17,500 ft.
22	111	12/7	Transmission Line	"	Resist	20		2.3	105	210					90		T.L.			9	42	
23	"	"	" "	"	"	30		2.19	143	"					100		"			10	42	
24	"	"	" "	"	"	40		2.0	160	"					100		"			"	"	
25	"	"	" "	"	"	50		1.8	162	"					"110"		"			"	"	
26	"	"	" "	"	"	60		1.7	173	220					"115"		"			"	"	
27	"	"	" "	"	"	80		1.5	178	200					"117"		"			"	"	
28	"	"	" "	"	"	100		1.3	169	180					"118"		"					
29	"	"	" "	"	"	150		1.0	150	130					"		"					
30	"	"	" "	"	"	200		0.8	129	110					"		"					
31	"	"	" "	"	"	355		.41	60	130					"120"		"			25	"-75"	
32	"	"	" "	"	"	600		.25	37.5	70					"118"		"					
33	104	12/1	Full Power Coupling	600	Fixt.	2.4	3.8	4.6	35	225	0.5				28		Trail	1	19	6	2180"	Fil. Volts at ¼ Power 10.6v.
34	"	"	Quarter " "	"	"	2.4	1.9	2.3	8.7	55	0				14		"	1	19	"	"	
35	"	"	Full " "	"	430'		2.7	2.8		225	0.5				53		"	3	80	17	"	
36	"	"	Quarter " "	"	"		1.4	1.35		55	0				30		"	3	80	"	"	

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Enclosure (JJ)

GO-2 TRANSMITTER TEST ADJUSTMENTS

HIGH-FREQUENCY UNIT, FINAL SUBMISSION OF MODEL

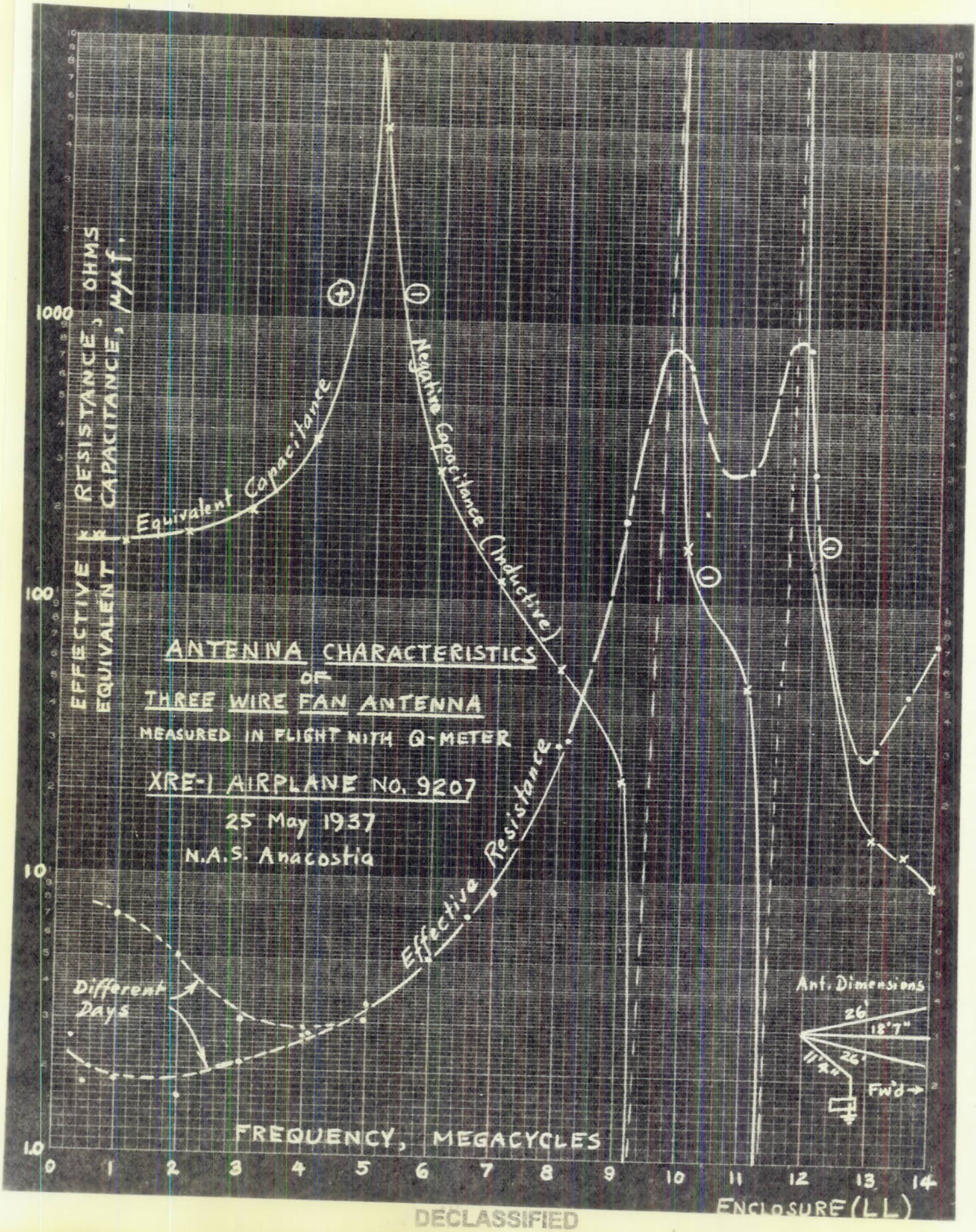
RADIO TEST SECTION
U.S. NAVAL AIR STATION
ANACOSTIA, D.C.

Generator: Type NEA-2
Emission: CW; any add'l. MCW under "REMARKS"
Dates of Tests: Nov. & Dec., 1936.

1 Line No.	2 Log p.	3 Date	4 Object of Test	5 Freq. Kcs.	6 Antenna ft.	7 Antenna Ohms	8 R.F. Antenna Current Amps.	9 R.F. Interm. Meter Amps.	10 R.F. Output Watts.	11 P.A. Plate Current M.A.	12 Compensation Cap. mfd.	13 M.O. Coil "A"	14 M.O. Tune "B"	15 I.A. Coil "C"	16 I.A. Tune "D"	17 P.A. Switch "E"	18 P.A. Cond. "F"	19 Ant. Cap. Switch "G"	20 Ant. Tune Coil "H"	21 Ant. Coupling "J"	22	23 Remarks
1	80	11/18	Tuning	3000	Fixt			5+	—	225	CW 1.5 MCW 2.5	1	311	1	25	1	32	OFF	8.31	8		(Equivalent Trail Ant. 56 ft.
2	88	11/21	Altitude Breakdown	"	Fixt			CW 7.2 MCW 7.4		225	1.5	1	311	1	25	1	32	OFF	30.8	8		(4.9 amp CW; 5.14 a MCW
3	"	"	" "	"	13'			CW 4.6 MCW 4.8		225	1.5								45	20		Shortest Ant.; Breaks Down
4	"	"	" "	"	96'			CW 1.5 MCW 1.6		225	1.5								0	8		Longest Fundamental Ant.
5	96	11/25	Altitude Breakdown	"	Fixt			7+		225	1.5	1	311	1	26	1	33	OFF	30.8	9		
6	"	"	" "	"	25'			6.3		225	1.5								41.1	9		Shortest Specified Ant; broke down
7	"	"	" "	"	96'			1.4		225	1.5								0.0	76		Longest fundamental ant.
8	"	"	" "	"	13'			5.7		225	1.5								45	9		Shortest antenna
9	104	12/1	Power & Coupling	"	Fixt	2.4	6.5	7.1	101	225	1.5								30	9		Full Power
10	"	"	" "	"	Fixt	2.4	3.25	3.75	25	60	0.0								30	0		Quarter Power
11	"	"	" "	"	96'	47	1.60	1.45	120	225	1.5								0.0	MAX 90		Full Power
12	"	"	" "	"	96'		.80	.70		70	0.0								0.0	26		Quarter Power
13	"	"	" "	"	254'	75	1.1	1.0	90	MAX 165	0.5								0.0	90		Note Low Plate m.a.
14	"	"	" "	"	254'		.55	.5		70	0								0.0	32		Quarter Power
15	106	12/1	Power & Coupling	4080	Fixt	2.75	7.0	7+	134	225	1.5							OFF	17.4	13		
16	"	"	" "	"	Fixt	2.75	3.5	3.7	34	65	0							OFF	17.4	1		Quarter Power
17	"	"	" "	"	65'	60	1.7	1.5	173	MAX 200	1.0							OFF	0.0	MAX 90		
18	"	"	" "	"	65'		0.9	0.8		65	0							OFF	0.0	35		
19	"	"	" "	"	181'		1.1	1.0		MAX 140	0.5								0.0	MAX 90		(125' = Half λ antenna)
20	"	"	" "	"	181'		0.6	0.5		60	0								0.0	40		Quarter Power.
21	80	11/18	Antenna Matching	4135	Fixt	2.8		5+		225	1.5	2	1291	2	34	2	34	OFF	4.17	13		
22	88	11/21	" "	"	Fixt			7+		225	1.5	2	1291	2	33	2	34	OFF	17.4	6		(Equiv. trail. ant. 50', 3.7 amp. CW)
23	"	"	" "	"	0'			5.9		225								OFF	33.9	7		Antenna retracted into Fairlead
24	"	"	" "	"	65'			1.6 CW 1.8 MCW		210								OFF	0	MAX 90		Longest ¼ λ resonant Ant.
25	96	11/25	Altitude Breakdown	"	Fixt			6.9		225	1.5 CW 2.5 MCW	2	1291	2	34	2	34	OFF	17.4	14		O.K. at 8,000 ft.
26	"	"	" "	"	25'			6.5		225									24.6	14		Shortest Specified Ant.
27	"	"	" "	"	64'			1.6		220									0	78		Longest ¼ λ resonant Ant.
28	136	12/16	½ λ Dummy Antenna	"	Resist.	∞	0			230								1	34.3	16		Internal Power Dissipation
29	"	"	" "	"	Resist.	8700	.113		106	230								1	35.1	38		"Zircon" Rod Dummy
30	"	"	" "	"	Resist.	1660	.320		170	215								1	32.8	80		" " "
31	"	"	" "	"	Resist.	1660	.310		160	230								2	25.7	56		" " "
32	88	11/21	Altitude Breakdown	6600	Fixt			4.0		225	1.5	4	1574	3	65	3	70	3	15.6	43		
33	102	11/30	Antenna Matching	"	25'			9.3		225	1.5	4	1574	3		3		OFF	9.0	40		¼ λ Resonance
34	"	"	" "	"	50'			.4		225								1	16.4	61		½ λ "
35	"	"	" "	"	95'			2.4		225								OFF	9.0	56		¾ λ "
36	104	12/1	Power Reduction	"	Fixt	7.1	3.7	3.1	97	225	1.5							3	14.4	37		Freq. Doubling, Full Power
37	"	"	" "	"	Fixt	"	1.85	1.55	25	65	0							3	14.4	10		" " Quarter "
38	"	"	" "	"	Fixt	"	3.75	3.1	100	225	1.5							3	14.4	38		" Singling, Full "
39	"	"	" "	"	Fixt	"	1.85	1.5	25	65	0							3	14.4	13		" " Quarter "
40	"	"	" "	"	35'	35	2.1	1.9	154	225	1.5							OFF	0	72		
41	"	"	" "	"	35'		1.05	.95		65	0							OFF	0	26		
42	"	"	" "	"	106'	70	1.55	1.4	168	200	1.0							OFF	0	90		
43	"	"	" "	"	106'		.76	.70		70	0							OFF	0	31		
44	106	12/1	Power Reduction	8160	Fixt	30	2.5	1.0	187	225	1.5							1	19.8	52		Full Power
45	"	"	" "	"	Fixt	"	1.25	0.4	47	70	0							1	19.8	20		Quarter Power
46	80	11/18	Antenna Matching	8270	25'			1.5		200	CW 1. MCW 2.	2	1291	4	45	4	52	OFF	16.0	90		
47	88	11/21	Altitude Breakdown	"	Fixt			1.5		225	1.5	2	1291	4	44	4	52	1	20.8	60		
48	"	"	" "	"	28'			1.0		150	.5							OFF	0	30		Longest ¼ λ resonant
49	"	"	" "	"	0'			7.0		225	1.5							OFF	14.8	8		Antenna retracted
50	96	11/25	" "	"	25'			2.3		225	1.5	2	1291	4	43	4	52	OFF	8.4	57		Shortest specified Ant.
51	136	12/16	½ λ Dummy Antenna	"	Resist.	∞	0			230								1	15.3	14		
52	"	"	" " "	"	Resist.	8700	.065		37	230								2	12.1	20		"Zircon" Res. Rod
53	"	"	" " "	"	Resist.	1660	.33		180	230								1	14.8	51		" " "
54	90	11/23	Altitude Drift	12405	Fixt			1.0		225	1.0	4	1151	5	69	5	72	1	10.0	70		
55	80	11/18	Antenna Matching	13575	Fixt			0.5		225	CW 1.0 MCW 1.5	4	1771	5	83	5	89	OFF	5.1	62		
56	96	11/25	Altitude Breakdown	"	0'			7+		225								OFF	5.6	20		Antenna retracted
57	"	"	" "	"	25'			2.8		225	1.5							OFF	7.2	43		Shortest specified Ant.
58	104	12/1	Power Reduction	"	Fixt	48	1.5	1.0	108	225	1.0							OFF	11.1	53		Full Power
59	"	"	" "	"	Fixt	"	.3	.5	39	80	0							OFF	11.1	22		Quarter Power
60	"	"	" "	"	11'	9	4.5	4.0	180	225	1.0							OFF	0	37		
61	"	"	" "	"	46'	25	2.7	2.4	182	225	1.0							OFF	0	58		
62	80	11/18	Antenna Tuning	14400	Fixt	130		Below 0.5		225	CW 1.0 MCW 1.5			-				OFF	5.1	56		Highest Freq.

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Enclosure (KK)



ENCLOSURE (LL)

DECLASSIFIED

RADIO TEST LABORATORY, N.A.S. Anacostia, DC DATE 2 December 1936

Receiver: RU-2, Ser. 276, CW pos'n, reduced Vol. OBSERVER M.P.H.

Rec. Antenna: 85 foot vertical single wire.

Rec. Signal Source: LN Oscillator TIME

Reference Alignment (0°) directly to Antenna.

Reception Efficiency: 100% is obtained with antenna directly to receiver, volume adjustment set to give from 5 to 10 volts output.

TEST

350 and 8200 kcs RECEPTION THROUGH CO-2 I.F. TRANSMITTER UNIT

	COL. 1	COL. 2	COL. 3	COL. 4	COL. 5	COL. 6	COL. 7	COL. 8
	Rec'd. Freq. kcs	Trans. Ant. Circt. Switch "F"	Trans. Ant. Load. Ind'r. "G"	Trans. Ant. Tuning Variom. "H"	Fixed Alignm't CW RECEPTION Input Align. Pos'n:	Rec. Efficiency %	Best Alignm't CW RECEPTION Input Align. Pos'n:	Rec. Efficiency %
1								
2	350	Trans. L.	-	-	5°	59%	-5°	70%
3	350	Fixed	1	54	0°	Below 1%	75°	1%
4	350	"	1	100	5°	37%	35°	42%
5	350	"	1	0	5°	48.5%	-5°	93%
6	350	"	2	6.5	5°	Below 1%	80°	2%
7	350	"	3	0	5°	58%	-5°	70%
8								
9	8,200	Trans. L.	3	0	0°	60%	-35°	80%
10	"	Fixed	3	0	0°	67%	-25°	90%
11	"	"	1	100	0°	64%	-30°	90%
12	"	Trail.	3	0	0°	5.5%	35°	7.8%
13	"	"	1	0	0°	8.8%	55°	13.9%
14	"	"	1	50	0°	6%	55°	13.9%
15	"	"	1	100	0°	5.2%	45°	7.2%
16								

Note: 8,200 kcs would normally be received on the receiver connected through H.F. (rather than I.F.) transmitter, which provides measured reception efficiency of about 98%.

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Enclosure (MM)

RADIO TEST LABORATORY, N.A.S. ANACOSTIA, D.C. DATE 2 December 1936

Receiver: RU-2, Ser.276, CW pos'n, reduced Vol. OBSERVER M.P.H.

Rec.Antenna: 85 foot vertical single wire.

Rec.Signal Source: WMAL B.C. Carrier, 630 kcs. TIME

Reference Alignment: (0°) directly to antenna, without transmitter

Reception Efficiency: Receiver connected and trimmed directly to antenna considered as 100%, with output volume set to 7.2 volts.

TEST 630 KCS RECEPTION THROUGH GO-2 I.F. TRANSMITTER UNIT

	COL. 1	COL. 2	COL. 3	COL. 4	COL. 5	COL. 6	COL. 7	COL. 8
					Fixed Alignm't CW RECEPTION		Best Alignm't CW RECEPTION	
	Rec'd. Freq. kcs	Trans. Ant. Circ't. Switch "F"	Trans. Ant. Load. Ind'r. "G"	Trans. Ant. Tuning Variom. "H"	Input Align. Pos'n:	Rec. Efficiency %	Input Align. Pos'n:	Rec. Efficiency %
1	630	Trans.L.	3	0	0°	43%	-15°	70%
2	"	" "	1	100	0°	43%	-15°	70%
3	"	Trail.	3	0	0°	43%	-25°	72%
4	"	"	3	100	0°	36%	-35°	85%
5	"	"	2	0	0°	39%	-35°	84%
6	"	"	2	50	0°	35%	-50°	95%
7	"	"	2	100	0°	30%	-80°	108%
8	"	"	"	"	-25°	43%	-	-
9	"	"	1	0	-25°	48%	-60°	102%
10	"	"	1	50	-25°	32%	-105°	107%
11	"	"	1	100	-25°	26%	-255°	88%
12	"	Fixed	3	0	-25°	72%	-15°	73%
13	"	"	3	50	-25°	46%	-48°	83%
14	"	"	3	100	-25°	8.5%	30°	26%
15	"	"	2	0	-25°	3%	55°	11%
16	"	"	2	50	-25°	7.5%	15°	15%
17	"	"	2	100	-25°	13%	10°	16%
18	"	"	1	0	-25°	10%	5°	16%
19	"	"	1	50	-25°	11%	5°	16%
20	"	"	1	100	-25°	12%	0°	17%

Enclosure (NN)

DECLASSIFIED

RADIO TEST LABORATORY, N.A.S. ANACOSTIA, DC. DATE 8 December 1936

Receiver: RU-2, Ser.276, CW pos'n,reduced Vol. OBSERVER M.P.H.

Rec.Antenna: 85 foot vertical single wire.

Rec.Signal Source: WJSV B.C.Carrier,1460 kcs. TIME

Reference Alignment (0°) directly with antenna, not through transmitter.

Reception Efficiency: 7.1 volts Output considered as 100%, to which receiver is adjusted directly on antenna.

TEST 1460 KCS RECEPTION THROUGH GO-8 I.F. TRANSMITTER UNIT

	COL. 1	COL. 2	COL. 3	COL. 4	COL. 5	COL. 6	COL. 7	COL. 8
	Rec'd. Freq. kcs	Trans. Ant. Circ't. Switch "F"	Trans. Ant. Load. Ind'r "G"	Trans. Ant. Tuning Variom. "H"	Fixed Alignmt. CW RECEPTION Input Align. Pos'n:	Rec. Efficienoy %	Best Alignm't. CW RECEPTION Input Align. Pos'n:	Rec. Efficienoy %
1	1460	Trans.L.	1	100	0°	68%	-5°	70%
2	"	Trail.	3	50	-5°	28%	-295°	85%
3	"	"	3	100	-5°	17%	35°	39%
4	"	"	2	0	-5°	22%	260°	23°
5	"	"	2	50	-5°	13%	30°	30%
6	"	"	2	100	-5°	7.6%	70°	16%
7	"	"	1	0	-5°	8.5%	90°	23%
8	"	"	1	50	-5°	6%	75°	15%
9	"	"	1	100	-5°	5.5%	70°	11%
10	"	Fixed	3	0	-5°	19%	40°	37%
11	"	"	3	50	-5°	56%	-6°	57%
12	"	"	3	100	-5°	57%	0°	58%
13	"	"	2	0	-5°	61%	0°	63%
14	"	"	2	50	-5°	59%	-3°	61%
15	"	"	2	100	-5°	60%	-5°	60%
16	"	"	1	0	-5°	60%	-5°	60%
17	"	"	1	50	-5°	60%	-5°	60%
18	"	"	1	100	-5°	60%	-5°	60%
19								
20								

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Enclosure (00)

RADIO TEST LABORATORY, N.A.S. ANACOSTIA, D.C. DATE 3 December 1936

OBSERVER M.P.H.

Gene ...sed: NEA-1A #252; NEA-2 #395; NEB-1A #1.

I.F. ...ter Unit tuned to 500 kcs.

H.F. ...ter Unit tuned to 8270 kcs. TIME

Norm ... Power" with 230 m.a. P.A. plate current. (Max. Compens. Cap. 7)

Norm ...ent Volts 10.0, maintained to within + or - 0.2 volts

TEST ...PPLY VOLTAGE COMPENSATION of

...E MODEL GO-2 RADIO TRANSMITTING EQUIPMENT

	COL. 2	COL. 3	COL. 4	COL. 5	COL. 6	COL. 7	COL. 8
				CW Transmission		MCW Transmis.	
	A.C. Frequency, cycles	A.C. Input Volts	Transmitter Unit & Power	P.A. Plate m.a.	Compensation mfd.	P.A. Plate m.a.	Compensation mfd.
1	795	123	IF-Full	230	1.5	210	1-1.5
2	795	121	IF-Low	130	0.5	110	0.5
3	810	123	HF-Full	230	1.0	220	1.0
4	810	124	HF-Low	80	0	80	0
5	590	106	IF-Full	195	2.5	175	2.5
6	590	108	IF-Low	105	2.5	110	2.5
7	590	106	HF-Full	205	3.0	200	3.0
8	590	110	HF-Low	70	2.5	70	2.5
9	810	119	IF-Full	215	1.0	190	1.0
10	810	118	IF-Low	165	0.5	165	0.5
11	810	120	HF-Full	230	2.0	230	3.5
12	810	120	HF-Low	70	0	70	0
13	595	112	IF-Full	200	2.0	175	2.0
14	595	112	IF-Low	140	1.5	140	1.5
15	595	112	HF-Full	230	2.5	215	3.0
16	595	112	HF-Low	70	1.5	70	1.5
17	810	126	IF-Full	230	0.5	210	0.5
18	810	130	IF-Low	115	0	120	0
19	820	126	HF-Full	230	1.0	220	1.0
20	820	130	HF-Low	70	0	70	0

DECLASSIFIED

Enclosure (PP)