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SUBJECT

Preliminary Model GF-3 Equipments

Manufactured by

Aircraft Radio Corporation.

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NAVAL RESEARCH LABORATORY

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14 September 1936

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BuEng. Prob. A1-11
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NAVY DEPARTMENT
BUREAU OF ENGINEERING

Report of Test

on

Preliminary Model GF-3 Equipments

Manufactured by

Aircraft Radio Corporation.

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D.C.

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Authorization: BuEng. ltr. C-NOs-42945(9-23-W3) of 25 September 1935.

Date of Test: 4 December 1935 to 25 August 1936.

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AUTHORIZATION

1. The tests herein reported were authorized by Bureau of Engineering letter, reference (a). Additional references pertinent to these tests are listed as references (b) to (e).

Reference: (a) BuEng. ltr. C-NOs-42945(9-23-W3) of 25 September 1935.
(b) BuEng. ltr. F42-1(11-8-W3) of 17 November 1934.
(c) NRL ltr. F42-1/43 of 25 March 1936.
(d) Specifications RE 13A 494B.
(e) Model RU-3A and GF-2 Instruction Book.

OBJECT OF TEST

2. The object of these tests is to determine the compliance of the equipment with the requirements of the specifications, reference (d).

ABSTRACT OF TEST

3. The equipment was checked for size and weight, mechanical construction and electrical performance.

4. The transmitter was tested for power output at various frequencies on each of the four plug-in coils. The oscillator and amplifier plate and screen current and the modulator plate and screen current were recorded.

5. The percentage of modulation was determined at various frequencies and input voltages. The audio harmonic distortion of the output and wave forms of the modulator were determined on these same frequencies. Frequency drift measurements were made over the temperature range specified in reference (d). The resetability of the transmitter was determined during flight tests.

6. The receiver was tested for sensitivity, selectivity, noise output, automatic volume control action, loop coupling, audio fidelity, overload, frequency drift, and resetability.

7. At the conclusion of the bench tests the equipment was submitted to the Naval Air Station at Anacostia for flight tests according to reference (b).

Conclusions

The tests of the Model GF-3 equipment were conducted on two preliminary models. One of these models was later modified by the contractor incorporating changes and some additional desirable features recommended at a conference at the Bureau of Engineering. As a result of these tests the following conclusions are reached:

(a) The material used and the workmanship are excellent and the equipment should give long and dependable service.

(b) Some units of the equipment were slightly oversize or overweight according to the requirements of reference (d).

(c) The equipment does not meet the requirements of reference (d) on the following:

Receiver
- Selectivity
- Automatic sensitivity control
- Audio fidelity
- Resetability of the receiver
- Frequency drift of the receiver
- Power drain on primary power source

Transmitter
- Percentage of modulation.

(d) The equipment satisfactorily met the requirements of reference (d) on the following:

Receiver
- Sensitivity
- Noise output
- Loop coupling
- Tuning characteristics

Transmitter
- Power output
- Percentage of modulation
- Frequency drift
- Resetability

(e) While not referred to in the specifications, the audio harmonic distortion was determined and found to be satisfactory.

(f) The method of control of the interior communication system and the control of the signal level in the head phones of the preliminary models, while they did not violate requirements of the specifications, were not entirely satisfactory. The modified model has satisfactorily corrected these conditions and in addition has so arranged the wiring that it is now possible to use a crystal frequency indicator in both the transmit or receive positions. A crank and a visual indicator have been added to greatly improve the antenna tuning of the transmitter. The slide arm rod of the plug-in coils has been marked to indicate the number of turns, which facilitates changing of frequency.

(g) The points wherein the equipment does not meet the requirements of the specifications are of a minor nature and will not detract seriously from the suitability and serviceability for Naval aircraft use.

Recommendations

It is recommended that:

(a) The oscillator-amplifier and modulator jacks of the transmitter be so arranged that the receiver test meter may be used for measuring these currents. Also, that the plug used for this purpose be such that there is no possibility of personnel coming in contact with high voltages.

(b) The microphone button be so arranged that it cannot be locked in position when depressed.

(c) The signal strength of the side tone in telegraph position be reduced.

(d) The output condenser tuning dial on the transmitter be located on the front panel instead of the side of the cabinet as is the case on the modified model submitted by the contractor.

(e) The fiducial marker on the remote tuning control of the receiver be mounted more rigidly than it is at present.

(f) The requirements for audio fidelity of the receiver at low audio frequencies be reduced in order to obtain a more satisfactory time constant in the detector circuit.

[redacted]

EQUIPMENT UNDER TEST

8. The Model GF-3 equipment consists of a transmitter capable of producing a CW radio frequency power output and peak modulated power output of at least 15 watts over the frequency range of 3000 to 4525 kilocycles and 12 watts over the frequency range of 6000 to 9050 kilocycles. Electrically this transmitter comprises a radio frequency oscillator, a radio frequency amplifier, a coupling circuit for transferring the radio frequency power to the antenna and a modulator stage for amplifying either internal or external modulation currents and modulating the radio frequency amplifier therewith. The modulator tube also acts as a tone oscillator generating an audio frequency modulating current for MCW telegraphy. The radio oscillator is a Type 89 tube connected as a triode, with the plate, suppressor and screen grids connected together to form a single anode. The radio amplifier stage consists of two Type 837 pentodes connected in push-pull. The modulator-audio oscillator tube is a second Type 89 tube connected as a pentode.

9. The equipment includes a receiver capable of collecting CW-MCW and Voice signals on frequencies from 224 to 13,575 kilocycles. The receiver comprises three stages of radio frequency amplification, a detector and one audio amplifier, an A.G.C. stage and a heterodyne oscillator. The radio amplifier tubes are Type 38078, the detector and A.G.C. tubes are Type 38077, and the combined oscillator and audio amplifier tube is a Type 38233.

10. A dynamotor driven by the ship's 12 volt storage battery supplies all the electrical power necessary to operate the equipment. Extension boxes and control cables permit remote control of the equipment in addition to local control.

METHOD OF TEST

11. A description of the methods used in conducting the tests follows.

12. The equipment was checked for size, weight and mechanical construction. It was then assembled and tested to determine its compliance with the electrical requirements of the specifications, reference (d).

13. The power output of the transmitter was determined using an artificial antenna as described in reference (d). The measurements were made with an r.f. ammeter in the ground side of the artificial antenna at various frequencies on each of the four plug-in coils.

14. For determining the percentage of modulation a beat frequency oscillator is coupled through a mixer to the horizontal plates of a cathode ray oscillograph. The output of the transmitter taken from across the artificial antenna was coupled to the vertical plates of the oscillograph. With the apparatus properly adjusted, photographic records were made of the resultant image produced on the screen of the oscillograph and the percentage of modulation calculated from the figures on the film.

15. For determining the audio harmonic distortion of the output a beat frequency oscillator was coupled through a mixer to the microphone jack of the transmitter. The output of the transmitter was coupled through a rectifier into a wave analyzer. The beat frequency oscillator was then adjusted to the audio frequency desired and the readings of the wave analyzer recorded at the various harmonics of these frequencies.

16. The audio wave form was determined by coupling a beat frequency oscillator through a mixer to the control terminals of a cathode ray oscillograph. The modulation transformer was coupled to the vertical plates of the oscillograph with a 250,000 ohm resistor across the terminals of the vertical plates. With the input voltage kept at a constant level, the figure produced on the screen of the oscillograph was observed at various settings of the beat frequency oscillator.

17. The frequency drift was taken by installing the transmitter in a temperature controlled chamber the output coupled to a Model LK frequency measuring equipment. The temperature was reduced to the minimum required and gradually increased to the maximum. Readings were taken at five minute intervals of the temperature and frequency drift, the latter as indicated by the frequency measuring equipment. These readings were made on the middle of the band of each plug-in coil unit.

18. The reset measurements of the transmitter were made during the flight test of the equipment. The transmitter was set on predetermined frequencies. The positions of all controls were recorded, the transmitter detuned and reset according to the recorded positions. The frequency was measured on the Model LF frequency measuring equipment at this Laboratory.

19. The sensitivity of the receiver was determined with the use of a standard signal generator to supply the input and a power output meter to measure the output. The standard signal generator was coupled to the receiver through an artificial antenna consisting of a 0.0001 mfd. fixed condenser in series with the antenna lead. This lead and the ground lead were six inches in length. With the receiver adjusted for maximum sensitivity the input voltage necessary to obtain standard output was recorded at various frequencies. The measurements were made on CW and MCW positions of the selector switch and on manual and automatic positions of the volume control.

20. The MCW selectivity measurements were made with the same apparatus as that used in making the sensitivity measurements. The procedure was as follows. The standard signal generator and receiver were tuned to resonance and for standard output. The standard signal generator was detuned and the multiplier adjusted to the next higher step (the attenuator remaining fixed). The signal generator was then retuned until standard output was again obtained. The setting of the tuning control of the standard signal generator was recorded in both positions and the selectivity calculated as the frequency difference of these settings. Measurements were made at various frequencies and at input values representing 10, 5, and 1% of resonance sensitivity. The CW selectivity measurements were made as above except that the test meter was plugged into the receiver test jack and the

signal level adjusted until a dip was noticed on the meter in the AVC position. This amounts to the use of the AVC tube for a vacuum tube voltmeter for indicating the r.f. voltage at the detector grid.

21. In measuring the noise output a standard signal generator was used and the receiver adjusted for standard output in the MCW position. With the modulation switch of the standard signal generator on the external position (which cuts off modulation) the output was recorded.

22. The action of the automatic volume control was determined with the use of a standard signal generator on CW and MCW signals. The input was adjusted to increasing values the output recorded and the ratio of input to output determined.

23. The loop coupling characteristics were determined using a standard signal generator for the input and measuring the relative sensitivity of the receiver in the antenna and loop positions. For this measurement the artificial antenna described above was used and for the loop condition a coil of negligible capacity having an inductance of .20 millihenries and a resistance of 6 ohms was connected in series across the loop terminals. A .00005 mfd. fixed condenser was also connected across these terminals.

24. The audio fidelity measurements were made by coupling a beat frequency oscillator to a standard signal generator. The receiver was adjusted for standard output in the MCW position. With the apparatus properly adjusted and all other controls remaining fixed, the output of the receiver was recorded at various frequencies of the beat frequency oscillator.

25. The overload measurements were made using a standard signal generator for the input source with the output of the receiver coupled to an oscillograph. The input was adjusted to produce output signals up to 300 milliwatts and the figure on the oscillograph was observed.

26. The frequency drift measurements of the receiver were made at a constant ambient temperature and at variable ambient temperature. In the latter case the receiver was mounted in a temperature controlled chamber and the temperature varied over the specified range. In both cases the procedure was the same. A Model LD-2 heterodyne calibrator was used for the input and an interpolation oscillator to beat against the output of the receiver. Readings were taken at 5 minute intervals over a period of 60 minutes for the constant temperature test and at 5 minute intervals over a period of time necessary to change the ambient over the range specified for the variable temperature test.

27. The reset measurements of the receiver were made using a standard signal generator for the input source and a heterodyne calibrator to beat with the output of the receiver. The original settings of the controls of the receiver on a selected frequency were recorded and the receiver then detuned and reset from both clockwise and counterclockwise directions. From the results the frequency difference of the original and reset positions were determined. These tests were made on both local and remote controls of the receiver.

DATA RECORDED DURING TEST

28. Data recorded during the tests in the form of tables, charts and photographs are appended to this report. This data which are listed below and other data are discussed in "Results."

29. Tables including the actual and allowable weights and measurements were made.

30. Transmitter data were recorded on the following:

(a) Power output.
(b) Current values.
(c) Power drain on primary power supply.
(d) Percentage of modulation.
(e) Audio harmonic distortion.
(f) Frequency drift.
(g) Reset measurements.

31. Receiver data were recorded on the following:

(a) Sensitivity.
(b) Selectivity.
(c) Noise output.
(d) Loop coupling.
(e) Automatic volume control action.
(f) Audio fidelity.
(g) Reset measurements.
(h) Frequency drift (constant temperature).
(i) Tuning characteristics.
(j) Frequency change due to voltage variation.
(k) Frequency drift (variable temperature).

DISCUSSION OF PROBABLE ERRORS

32. Following is a list of apparatus used with the margin of error according to the manufacturer's guarantee:

(a) General Radio standard signal generator, Model LC-A, Serial #2,	± 10.0%.
(b) General Radio power output meter, Type 583-A, Serial #72,	± 5.0%.
(c) Weston r.f. meter, 0-1.5 amps., Type 425, Serial #86592,	± 2.0%.
(d) Weston d.c. ammeter, 0-15 amps., Model 45, Serial #40604,	± 2.0%.
(e) Weston d.c. milliammeter, 0-300 amps., Model 301, Serial #1049081,	± 2.0%.
(f) General Radio beat frequency oscillator, Type 713-A, Serial #209,	± 2.5%.
(g) General Radio heterodyne oscillator, Model LD-2, Serial #1,	± .005%.
(h) General Radio interpolation oscillator, Type 617-A, Serial #30,	± .001%.
(i) General Radio wave analyzer, Type 636-A, Serial #102,	± 2.5%.
(j) RCA radio receiving equipment, Model RAB, Serial #1,	-
(k) NRL frequency measuring equipment, Model LF, Serial #1,	± .0025%.

(l) Radio Research Co. frequency measuring equipment, Model LK, Serial #1, ± .001%.
(m) General Radio electron oscillograph, Type 687A.
(n) NRL mixer unit.
(o) Refrigerator unit, Frigidaire, ± 1°C.

RESULTS

33. The tests of the subject equipment were made with the two original preliminary models as submitted by the contractor. Since then as a result of these tests a number of modifications were recommended, some of which have already been incorporated in one of the two preliminary models. These modifications will be treated in detail in the following discussion.

34. The results of these tests wherein the equipment does not meet the requirements of the specifications, reference (d), will be discussed in the order of the paragraphs in which they appear. In those paragraphs not discussed, the equipment will be regarded as in full compliance with the specifications. The numbers of the following sub-paragraphs are in agreement with the numbers of the paragraphs of the specifications.

II. GENERAL

2-3. This equipment is of rugged construction and of the best material suitable for each specific employment.

2-4. The workmanship is of a very high order and is indicative of long and dependable service.

2-5. The material used is in accordance with this paragraph and where necessary has been treated to prevent corrosion.

2-7. The equipment operates satisfactorily in temperatures from -30 to +55°C. which is the maximum range of the equipment used to make this test.

2-8. A 2 kilowatt pure CW output was not available to conduct this test; however, the equipment is designed to withstand or has a suitable protective device incorporated to prevent damage due to overload.

2-10. Actual service use over a long period of time is necessary to determine the compliance of the equipment with this paragraph.

2-11. Apparatus is not available at this Laboratory to conduct the tests required by this paragraph. However, during the flight tests the equipment was subjected to numerous take-offs and landings and positions of various degrees from vertical and performed satisfactorily at all times.

2-12. Wooden dowels are used for the low frequency coil forms. No satisfactory substitute seems available.

2-13. The interchangeability of parts meets the requirements of this paragraph. The transmitter coils are calibrated for operation with the transmitter bearing the same serial numbers. If used with any other transmitter, they will perform satisfactorily but the calibration charts may be inaccurate.

2-15. The equipment does not in all cases meet the requirements of the specifications as regards size and weight. A discussion of these discrepancies appears later in these results.

2-17. Provision has been made for protection of personnel from coming in contact with high voltages. However, while the jacks for measuring the transmitter currents are insulated, a standard plug which employs the sleeve for one contact when plugged into the jack has a high voltage from sleeve to case which is at ground potential. It has been recommended that these circuits be so arranged that the receiver test meter may also be used for measuring the above mentioned transmitter currents. This can be done and by the use of a three contact plug with the sleeve grounded the high voltage hazard will be eliminated. Another condition exists in the transmitter whereby it is possible to come in contact with high voltage. The plate terminals of the amplifier tubes which are located at the top of the tubes are so located that these terminals are directly under the removable cover. The purpose of this removable cover is for the replacement of tubes. There is a conspicuous red warning plate, suitably engraved, mounted on the removable cover. When this cover is removed, it is possible to come in contact with the high voltage on the plate terminals. However, in the event of this contact occurring it must be construed as carelessness rather than accidental.

2-26, 2-27, 2-28. The items referred to in these paragraphs require testing before being approved for use in the construction of the equipment.

2-40. Electrolytic condensers are not used.

2-45. The receiver tubes include three 38078, two 38077 and one 38233. The transmitter tubes include two 89's and two 837's.

2-49, 2-50, 2-51, 2-52. These paragraphs are "Type Test" requirements. Parts and equipment are not available to conduct these tests.

III. MECHANICAL REQUIREMENTS

3-2. Item (19) One set of tubes only was supplied with the equipment. Items (21), (25), (26) were not supplied with the equipment.

3-3. The transmitter meets the requirements of this paragraph except that it is 1/4 inch oversize in width. See Table 31. The modified model includes in addition a small crank replacing the tuning knob of the antenna tuning condenser, a window and dial has been provided on the side of the transmitter for indicating the tuning of this condenser.

The slide rod of the antenna coil has been graduated to indicate the amount of coupling turns in the circuit as the antenna tap slide is adjusted. The receiver test meter has been redesigned and the transmitter test meter jacks provided with shunt resistors to permit the use of the same meter for test of both the receiver and transmitter. A satisfactory calibration chart with blank spaces of white ground enamel, to be mounted on the front of the transmitter, has been devised.

3-5. The equipment meets the requirements of this paragraph and in addition has been provided with a jack and a special locked plug to accommodate a Type 26003-A key. It also has been provided with a "Radio - ICS" switch allowing the pilot and observer to talk radio or ICS according to the position of their respective switches. There is a cleared ICS position on the switch which removes the receiver output from the phones. The switch must be manually held in this position. On being released, it assumes the normal ICS position. In the normal ICS position, mixing of the receiver output with ICS at a reduced ICS level is obtained. This system provides for the use of a two-way microphone with throttle switch control or a three-way microphone with microphone button control. One feature of the system is the feeding of microphone noise to the receiver in case the microphone button is kept locked during throttle switch control. However, in flight tests conducted at the Naval Air Station, Anacostia, this noise has not appeared to be objectionable.

3-7. The junction box has been modified in the following manner. The antenna relay and throttle switch outlets have been moved to the top of the box. The power outlets per RE 49AA 122 have been provided at the bottom of the box energized at both transmit and receive positions. The "Rec.Only - Trans.Rec." switch has been removed.

3-9. The dynamotor unit meets the requirements of this paragraph except that the voltage drop resistor for the CFI and receiver is located in the junction box and the unit is oversize 1/4 inch in width and 3/16 inch in height.

3-10. The receiver meets the requirements of this paragraph except that it is oversize 1/8 inch in width and 3/16 inch in height. See Table 32.

(5) The antenna-loop transfer switch and the antenna trimming condenser crank are mounted on the left side of the front panel.

3-12. The heterodyne oscillator switch is marked "CW-MCW."

3-13. The equipment meets the requirements of this paragraph except for backlash which will be discussed in a later paragraph concerning reset of the receiver.

3-15. The antenna relay unit is 1.2 ounces overweight. See Table 33.

3-21. The connecting cables referred to in the specifications as numbers 237, 280, 231, and 133 are marked numbers 37, 80, 121, and 233 respectively.

3-24. The test meter is so designed and the associated circuits so arranged that they can be used in testing both the receiver and transmitter.

3-25. Slip covers have been supplied for the transmitter and receiver.

3-32 to 3-38 inclusive. A life test is necessary to obtain accurate results. The dynamotor is of the same type of construction as similar units which have given satisfactory performance over long periods of service use.

3-46. No tools were supplied with this equipment.

IV. DEFINITIONS

This section describes methods and values to be used in conducting these tests and does not require comment.

V. OPERATING CHARACTERISTICS

5-1. The specified frequency range is covered with four plug-in coils. These coils covering the ranges 3000 to 3675 kilocycles, 3675 to 4525 kilocycles, 6000 to 7350 kilocycles and 7350 to 9050 kilocycles.

5-2, 5-3. The requirements of this paragraph are met satisfactorily and in addition the modified model includes ICS control by both pilot and operator. There are two positions for the ICS switch. One of these permits a mixed signal of ICS and radio and the other a clear channel for ICS. In the latter case the switch must be manually held in place. On being released the switch assumes the mixed position. This arrangement makes it impossible for the equipment to be accidentally left in a position wherein there is no radio reception.

5-4. Except at full gain the pilot has a greater signal strength in his head phones than that selected by the operator on the MVC position. He may reduce this signal to any level he desires by adjusting his own volume control without affecting the signal of the operator. On the AVC position each has full individual control of the signal level in his head set.

5-7. Due to resonance effects between the coils of the dual set 545-850 and 3000 to 4525 kilocycles, an unstable condition existed which greatly reduced the sensitivity of the receiver on frequencies of from approximately 4200 kilocycles to the maximum of the coil or 4590 kilocycles. On the modified set the 545-850 kilocycle band was changed to 540-825 kilocycles. This necessitated a change in the 850-1330 band to 825-1330 to obtain full coverage of the frequency range of the receiver. This change fully corrected the above mentioned undesirable condition.

5-16. Temperature tests were made on the equipment, the results of which appear under more specific paragraphs of these specifications. This

Laboratory is not equipped to conduct the humidity tests.

VI. ELECTRICAL REQUIREMENTS

6-2. The transmitter is adapted for the transmission of unmodulated continuous wave, modulated continuous wave and radio telephony. Tuning is accomplished on the front panel by means of a dial for control of the master oscillator, and a small tuning control (not a dial) for tuning the amplifier to resonance. The indicating dial for this control is located on the left side of the cabinet. A thermal ammeter is also located on the front panel for indicating antenna current.

6-3. The frequency drift meets the requirements of this paragraph. The total drift on 3500 kilocycles over 75.5° change in temperature was 3000 cycles or .085 per cent. The drift over 50° change in temperature after a five minute warm-up period was 1350 cycles or .038 per cent. The total drift on 4000 kilocycles over 76° change in temperature was 2600 cycles or .065 per cent and the drift over 53.5° change in temperature after a five minute warm-up period was 1400 cycles or .035 per cent. The total drift on 6500 kilocycles over 77° change in temperature was 4400 cycles or .067 per cent and the drift over 51.5° change in temperature after a five minute warm-up period was 2100 cycles or .032 per cent. The total drift on 8000 kilocycles over 72.5° change in temperature was 5450 cycles or .068 per cent and the drift over 51° change in temperature after a five minute warm-up period was 2600 cycles or .032 per cent. The results of these tests are shown on Tables 26, 27, 28, 29 and Plates 9, 10, 11, 12. The reset measurements which were well within the requirements of this paragraph are shown on Table 30.

6-4. Calibration charts are supplied with this equipment and are mounted on the panels of the plug-in coils. The accuracy of the calibration meets the requirements of the specifications.

6-5. The percentage of modulation meets the requirements of this paragraph except at the external modulation frequency of 100 cycles on 8050 kilocycles. With the maximum allowable audio frequency voltage of 0.5 volt, the percentage of modulation was 78 per cent. The results of these tests are shown on Table 23 and Plates 13, 14, 15 and 16.

6-6. The power output meets the requirements of this paragraph. The results of the measurements are shown on Table 20. The values of output shown on the table are total output on CW, average output on MCW, and carrier only on Voice. Since the modulation capabilities of the transmitter are in excess of 90 per cent, the peak power on MCW or Voice is in all cases more than required by the specifications.

6-7. The power drain from the power source of 14 volts was 9.4 amps. or 1.4 amps. over the allowable 8 amps. The total drain of the entire equipment was 10.9 amps. or 0.1 amp. less than the allowable maximum of 11 amps. The results of this test are shown on Table 22.

6-8. Break-in communication is satisfactory on the CW and MCW positions, but due to the large time constant is not possible in the AVC position.

6-12. The transmitter side tone on CW and MCW in the "Manual" position is excessive. In the "Auto" position the operator can reduce the signal in his headphones but as stated above, at the expense of break-in communication.

6-15. With proper experience of the personnel the frequency can be changed in the time specified in this paragraph.

6-17. Extended operation under service conditions will be necessary to determine this requirement.

6-20. The receiver is capable of operating satisfactorily over the specified frequency range. Reception can be transferred from antenna to loop by means of a switch mounted on the left side of the front panel. This switch may be operated by either local or remote control.

6-21. The frequency range from 224 - 13,575 kilocycles is covered by nine plug-in coils, three of which are dual coils.

6-22. The frequency bands of 224 - 350 kilocycles and 350 - 545 kilocycles are covered by a dual coil. The frequency bands of 545 - 850 and 3000 - 4525 kilocycles are covered by a dual coil and the frequency bands 545 - 850 kilocycles and 5200 - 7700 kilocycles are covered by a dual coil. The 545 - 850 kilocycle band of the two latter coils has been changed to 540 - 825 kilocycles necessitating a change in the 850 - 1330 kilocycle band to 825 - 1330 for the reason explained in paragraph 5-7.

6-32. The sensitivity of the receiver meets the requirements of this paragraph. The results of this test are shown on Table 1.

6-33. The loop coupling meets the requirements of this paragraph. The results of this test are shown on Table 4.

6-34 and 6-35. The selectivity of the receiver does not meet the requirements of this paragraph. The results of this test are shown on Table 2. The discrepancy is slight.

6-36. The audio fidelity of the receiver does not meet the requirements of this paragraph. The results of this test are shown on Table 6.

6-37. The receiver does not meet the overload requirement of 300 milliwatts undistorted output. The maximum undistorted output is 250 milliwatts. There is slight cutoff of the negative peak at 300 milliwatts. However, no distortion is apparent to the ear.

6-38. The noise output measured as specified was negligible, being not over 0.9 milliwatts at any frequency. The results of this test are shown on Table 3.

6-39. Laboratory and flight tests indicate that the microphone tendencies are negligible.

6-43. The loop coupling is such that direction finding is satisfactory with a trailing wire antenna not over 50 feet in length. A trailing wire antenna of 100 feet or longer materially reduces the sharpness and accuracy of radio bearings.

6-49. The receiver meets the requirements of this paragraph. The results of this test are shown on Table 13.

6-51. Use of the equipment under service conditions over a long period of time is necessary to determine the requirements of this paragraph.

6-52. The automatic volume control does not meet the requirements of this paragraph on CW. The results of this test are shown on Table 5. The usefulness of the equipment should not be impaired by this condition.

6-55. The frequency drift of the receiver does not meet the requirements of this paragraph. The drift over the first 10 minutes is well within the requirements, but the drift over the next 50 minutes exceeds the requirements. However, the total drift over the total 60 minutes is within the specified limits. The results of the test are shown on Tables 10, 11, 12, 14 and Plates 1, 2, 3.

6-57. The frequency drift of the receiver does not meet the requirements of this paragraph. The results of this test are shown on Tables 15, 16, 17, 18, 19 and Plates 4, 5, 6, 7, 8.

6-58. The receiver resetability meets the requirements of this paragraph when resetting from the same direction as when making the original adjustment but does not meet these requirements when resetting from the opposite direction. The fiducial mark on the remote tuning control is not sufficiently rigid and for this reason in attempting to reset passes through the original frequency when approaching from either direction. The results of this test are shown on Tables 7, 8, 9.

CONCLUSIONS

35. The tests of the Model GF-3 equipment were conducted on two preliminary models. One of these models was later modified by the contractor incorporating changes and some additional desirable features recommended at a conference at the Bureau of Engineering. As a result of these tests the following conclusions are reached:

(a) The material used and the workmanship are excellent and the equipment should give long and dependable service.

(b) Some units of the equipment were slightly oversize or overweight according to the requirements of reference (d).

(c) The equipment does not meet the requirements of reference (d) on the following:

Receiver
- Selectivity.
- Automatic sensitivity control.
- Audio fidelity.
- Resetability of the receiver.
- Frequency drift of the receiver.
- Power drain on primary power source.

Transmitter
- Percentage of modulation.

(d) The equipment satisfactorily met the requirements of reference (d) on the following:

Receiver
- Sensitivity.
- Noise output.
- Loop coupling.
- Tuning characteristics.

Transmitter
- Power output.
- Percentage of modulation.
- Frequency drift.
- Resetability.

(e) While not referred to in the specifications, the audio harmonic distortion was determined and found to be satisfactory.

(f) The method of control of the interior communication system and the control of the signal level in the head phones of the preliminary models, while they did not violate requirements of the specifications, were not entirely satisfactory. The modified model has satisfactorily corrected these conditions and in addition has so arranged the wiring that it is now possible to use a crystal frequency indicator in both the transmit or receive positions. A crank and a visual indicator have been added to greatly improve the antenna tuning of the transmitter. The slide arm rod of the plug-in coils has been marked to indicate the number of turns, which facilitates changing of frequency.

(g) The points wherein the equipment does not meet the requirements of the specifications are of a minor nature and will not detract seriously from the suitability and serviceability for Naval aircraft use.

Table 1

RU-4A RECEIVER

SENSITIVITY

Standard Output 10 MW FULL GAIN POWER SUPPLY 14 V

Freq. Kcs.	MCV Input CW		MCV Input MCW		Freq. Kcs.	MCV Input CW		MCV Input MCW	
	Manual	Auto	Manual	Auto		Manual	Auto	Manual	Auto
230	0.9	0.9	3.3	4.0	2100	1.0	1.0	3.45	3.7
284	0.85	0.85	3.8	4.5	2615	0.7	0.7	3.18	3.45
340	0.65	0.65	3.25	3.9	3150	0.55	0.7	2.2	2.5
365	1.15	1.1	3.9	4.6	3125D	1.25	1.25	4.25	4.7
450	1.45	1.4	4.75	5.5	3800D	0.7	0.75	3.6	3.9
535	0.98	0.94	3.3	3.6	4450D	0.45	2.75 8.	3.2	3.65
565D	1.0	1.0	3.25	3.45	4075	0.8	0.8	3.15	3.45
700D	1.15	1.15	3.5	3.7	5050	0.6	0.6	3.15	3.45
835D	0.87	0.9	2.8	3.0	5995	0.62	0.5	3.2	3.65
570D	1.0	1.0	3.15	3.4	5350D	1.3	1.25	4.0	4.45
705D	0.95	0.95	3.15	3.4	6475D	1.28	1.13	4.0	4.5
840D	0.83	0.8	2.5	2.7	7485D	0.65	0.95	3.5	4.0
860	0.95	0.95	2.2	2.3	6200	1.7	1.7	7.0	8.0
1075	0.85	0.85	2.45	2.75	7575	1.15	1.5	6.5	8.0
1300	0.6	0.65	1.8	2.	8900	5.0	7.5	12.0	13.0
1370	0.55	0.55	1.55	1.7	9250	10.0	20.0	43.0	46.0
1700	0.5	0.5	1.8	2.	11350	7.5	7.0	35.0	40.0
2055	0.3	0.4	1.3	1.4	13400	7.0	6.7	25.0	36.0

Table 2

RU-4A RECEIVER

SELECTIVITY

Freq. Kcs.	Percentage of Resonance +10% Kcs.	+5% Kcs.	+1% Kcs.	-10% Kcs.	-5% Kcs.	-1% Kcs.
225D	4.2	5.3	8.6	3.9	5.3	8.9
290D	4.5	5.9	10.3	4.7	5.7	10.3
360D	5.5	7.4	12.9	6.0	8.0	14.7
560D	8.0	10.3	17.8	7.3	10.0	18.4
700D	11.3	14.5	24.9	8.8	11.3	21.7
840D	14.6	19.5	32.9	11.6	15.9	28.3
1090	13.3	17.8	31.3	12.4	16.9	30.3
1675	17.4	23.4	38.2	13.0	18.2	33.0
2000	19.6	27.8	45.1	14.7	21.3	37.7
2580	24.3	31.5	53.0	18.0	25.2	46.8
3100D	23.5	32.9	54.0	18.8	25.8	49.3
3800D	28.2	37.6	63.4	18.8	25.8	51.7
4200D	30.3	39.6	67.5	21.0	30.3	56.0
5100	24.5	33.4	58.0	20.0	29.0	53.5
6200	37.8	46.6	78.0	24.4	35.5	66.3
7600	39.1	52.1	91.0	26.0	32.5	71.5
9000	67.4	84.1	134.8	53.9	60.6	128.0
10500	59.8	73.1	113.0	59.8	73.1	146.2
12500	81.4	106.4	194.0	62.6	87.7	169.0
13575	89.2	113.0	208.2	71.4	101.2	190.0

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Table 3

RU-4A RECEIVER

NOISE OUTPUT

ADJUSTED FOR STD. OUTPUT (10 M.W.)

Kcs.	M.W.
287	.7
360	.9
2000	.4
6200	.1
9000	.2
13575	.1

Table 4

MCV INPUT FOR 10 M.W. OUTPUT

Freq. Kcs.	Antenna	Loop
340	.65	.45
535	.98	.68
835	.89	.84
1300	.5	.35
1500	.5	.3

Table 5

RU-4A RECEIVER

AUTOMATIC VOLUME CONTROL

	CW		MCW	
Freq. Kcs.	Input MCV	Output MW	Input MCV	Output MW
280	.9	10.	4.5	10.
280	9.0	130.	45.0	18.
280	90.0	140.	450.0	21.
280	900.0	150.	4500.0	26.
835	.9	10.	3.0	10.
835	9.0	130.	30.0	41.
835	90.0	150.	300.0	50.
835	900.0	160.	3000.0	55.
2055	1.0	10.	3.4	10.
2055	10.0	150.	34.0	45.
2055	100.0	180.	340.0	55.
2055	1000.0	190.	3400.0	56.
5050	.46	10.	3.3	10.
5050	4.6	200.	33.0	37.
5050	46.0	250.	330.0	43.
5050	460.0	280.	3300.0	48.
9250	20.0	10.	60.0	10.
9250	200.0	230.	600.0	30.
9250	2000.0	300.	6000.0	38.
9250	20000.0	320.	60000.0	45.
13400	6.5	10.	30.0	10.
13400	65.0	200.	300.0	33.
13400	650.0	230.	3000.0	37.
13400	6500.0	230.	30000.0	43.

Table 6

RU-4A RECEIVER

AUDIO FIDELITY

Freq. Kcs.	Freq. Cycles	Output Volts	Freq. Kcs.	Output Volts
570	50	1.73	3800	1.61
570	100	2.39	3800	2.19
570	200	2.45	3800	2.32
570	300	2.45	3800	2.32
570	400	2.45	3800	2.39
570	500	2.51	3800	2.39
570	600	2.51	3800	2.45
570	700	2.51	3800	2.45
570	800	2.51	3800	2.45
570	900	2.51	3800	2.45
570	1000	2.45	3800	2.45
570	1200	2.39	3800	2.45
570	1400	2.26	3800	2.39
570	1600	2.12	3800	2.32
570	1800	1.98	3800	2.19
570	2000	1.82	3800	2.12
570	2500	1.45	3800	1.82
570	3000	1.1	3800	1.55
570	4000	.77	3800	1.1
570	5000	.7	3800	.77

RU-4A RECEIVER

RESET MEASUREMENTS
(INCLUDING BACKLASH & TORQUE)

Table 7

Remote Control — 600 Kcs. — Local Control

Remote: Original Freq. Cycles	Counter Clockwise Reset Cycles	Counter Clockwise Diff. Cycles	Counter Clockwise %	Clockwise Reset Cycles	Clockwise Diff. Cycles	Clockwise %	Local: Original Freq. Cycles	Counter Clockwise Reset Cycles	Counter Clockwise Diff. Cycles	Counter Clockwise %	Clockwise Reset Cycles	Clockwise Diff. Cycles	Clockwise %
3000	2900	100	.016	2050	950	.158	3000	3050	50	.008	3650	650	.108
3000	3100	100	.016	2000	1000	.167	3000	2950	50	.008	3700	700	.117
3000	3200	200	.033	2000	1000	.167	3000	3050	50	.008	3625	625	.104
3000	3200	200	.033	2100	900	.150	3000	3000	0	–	3600	600	.100
3000	3050	50	.008	2000	1000	.167	3000	3070	70	.012	3675	675	.113
3000	3250	250	.042	2050	950	.158	3000	3050	50	.008	3725	725	.121
3000	3175	175	.029	2000	1000	.167	3000	2975	25	.004	3725	725	.121
3000	3175	175	.029	2000	1000	.167	3000	3070	70	.012	3700	700	.117
Average 3000	3131	131	.022	2050	950	.158	3000	3027	27	.004	3675	675	.113

Table 8

9000 Kcs.

Remote: Original Freq. Cycles	Counter Clockwise Reset Cycles	Counter Clockwise Diff. Cycles	Counter Clockwise %	Clockwise Reset Cycles	Clockwise Diff. Cycles	Clockwise %	Local: Original Freq. Cycles	Counter Clockwise Reset Cycles	Counter Clockwise Diff. Cycles	Counter Clockwise %	Clockwise Reset Cycles	Clockwise Diff. Cycles	Clockwise %
5000	5450	450	.005	-4800	9800	.109	3000	2900	100	.001	-2700	5700	.063
5000	5300	300	.003	-3700	8700	.097	3000	2975	25	.0003	-3100	6100	.068
5000	6050	1050	.012	-4500	9500	.105	3000	3100	100	.001	-2900	5900	.066
5000	6300	300	.003	-4500	9500	.105	3000	2550	450	.005	-2500	5500	.061
5000	5100	100	.001	-4600	9600	.107	3000	2750	250	.0028	-2500	5500	.061
5000	5300	300	.003	-4300	9300	.103	3000	2300	700	.0078	-3200	6200	.069
5000	6500	1500	.017	-4250	9250	.103	3000	3100	100	.001	-2700	5700	.063
5000	5250	250	.0028	-4300	9300	.103	3000	3100	100	.001	-3100	6100	.068
Average 5000	5656	656	.007	-4370	9370	.1041	3000	2847	247	.0028	-2837	5837	.065

Table 9

RU-4A RECEIVER

RESET MEASUREMENTS
(INCLUDING BACKLASH & TORQUE)

9000 Kcs.

Original Freq. Cycles	Counter Clockwise Reset Cycles	Diff. Cycles	%	Clockwise Reset Cycles	Diff. Cycles	%
4000	4500	450	.005	-3450	7450	.083
4000	4000	0	-	-4900	8900	.099
4000	4100	100	.001	-4150	8150	.090
4000	3550	450	.005	-4000	8000	.089
4000	4300	300	.003	-3750	7750	.087
4000	4500	500	.005	-3900	7900	.088
4000	3500	500	.005	-3925	7925	.088
4000	4100	100	.001	-4000	8000	.089
Average 4000	4070	70	.0009	-4010	8010	.089

This table same as 9000 kilocycles on Table 8 except with feducial marker removed and temporary mark scribed on control frame.

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RU-4A RECEIVER

FREQUENCY DRIFT CONSTANT TEMPERATURE

Table 10

300 Kcs.

Time Min.	Frequency Cycles
0	500
5	480
10	475
15	455
20	450
25	440
30	430
35	425
40	410
45	385
50	375
55	365
60	350

Total drift -
150 cycles - .05%.

Drift first 10 minutes -
25 cycles - .006%
(allowable .05% or
250 cycles).

Drift over 50 minutes
after first 10 minutes -
125 cycles - .04%
(allowable .02% or
250 cycles).

Table 11

6000 Kcs.

Time Min.	Frequency Cycles
0	3500
5	3000
10	2715
15	2500
20	2200
25	1930
30	1700
35	1400
40	1150
45	950
50	800
55	600
60	450

Total drift -
3050 cycles - .05%.

Drift first 10 minutes -
785 cycles - .013%
(allowable .05% or
250 cycles).

Drift over 50 minutes
after first 10 minutes -
2265 cycles - .037%
(allowable .02% or
250 cycles).

Table 12

9000 Kcs.

Time Min.	Frequency Cycles
0	5300
5	6100
10	5000
15	4500
20	4000
25	3500
30	2900
35	2300
40	1850
45	1600
50	1350
55	1150
60	950

Total drift -
5150 cycles - .057%.

Drift first 10 minutes -
1100 cycles - .012%
(allowable .05% or
250 cycles).

Drift over 50 minutes
after first 10 minutes -
4150 cycles - .046%
(allowable .02% or
250 cycles).

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Table 13

RU-4A RECEIVER

TUNING CHARACTERISTICS

KILOCYCLE DISTRIBUTION OF DIAL

Band Kcs.	0^D Kcs.	100^D Kcs.	Kcs. per Division Actual	Kcs. per Division Allowable
224 - 350 D	218.5	354	1.35	10.
350 - 545 D	345.	555	2.1	10.
545 - 850 D	538.	850	3.2	10.
850 - 1330	808.	1360	5.5	10.
1330 - 2040	1290.	2140	8.5	10.
2040 - 3000	1980.	3275	12.9	20.
3000 - 4575	2965	4590	16.2	20.
4000 - 6000	3860	6215	23.5	20.
5200 - 7700	5090.	7800	27.1	32.
6000 - 9050	5875.	9250	33.7	32.
9050 - 13575	8800	13850	50.	50.

Table 14

VOLTAGE VARIATION

Original 14 V	12 V Freq. Cycles	12 V Diff. Cycles	12 V %	16 V Freq. Cycles	16 V Diff. Cycles	16 V %
600 Kcs.						
1000 cycles	825	175	.029	1070	70	.012
9000 Kcs.						
1750 cycles	-3500	5250	.058	+3500	1750	.019

Table 15

RU-4A RECEIVER

FREQUENCY DRIFT

325 Kcs. Decreasing Temperature

Time Min.	Freq. Cycles	Temp. °C.	Freq. Diff. Cycles	%	Time Min.	Freq. Cycles	Temp. °C.	Freq. Diff. Cycles	%
0	2500	+23			70	2857	−3	+357	.11
2	2510	+23	+10	.003	75	2891	−4	+391	.12
5	2505	+20.5	+ 5	.0015	85	2958	−5.5	+458	.14
10	2491	+16.5	− 9	.003	95	2995	−7	+495	.15
15	2482	+13	−18	.006	105	3048	−8	+548	.168
20	2508	+11	+ 8	.0025	115	3095	−9	+595	.182
25	2565	+ 8	+65	.02	125	3145	−10.5	+645	.198
30	2516	+ 7	+16	.0049	135	3180	−11	+680	.21
35	2581	+ 5	+81	.025	155	3245	−12.5	+745	.23
40	2590	+ 3	+90	.03	175	3313	−14	+813	.25
45	2675	+ 2	+175	.054	195	3370	−15	+870	.267
50	2705	+ 1	+205	.063	215	3405	−16	+905	.278
55	2737	0	+235	.072	235	3455	−17	+955	.293
60	2798	− 1	+298	.092	255	3480	−18	+980	.3
65	2795	− 2	+295	.091	270	3510	−19	+1010	.32

Table 16

325 Kcs. Increasing Temperature

0	2500	−18			60	1790	+ 6	− 710	.218
5	2460	−18	− 40	.012	65	1720	+11	− 780	.24
10	2415	−13	− 85	.026	70	1625	+15	− 875	.27
15	2365	−11	−135	.041	75	1535	+19	− 965	.296
20	2300	−11	−200	.060	80	1455	+21	−1045	.322
25	2235	− 7	−265	.082	85	1350	+24	−1150	.354
30	2170	−10	−330	.101	90	1310	+27	−1190	.366
35	2130	− 6.5	−370	.113	95	1240	+29	−1260	.388
40	2070	− 0.5	−430	.132	100	1180	+31	−1320	.406
45	2000	0	−500	.15	105	1110	+33	−1390	.428
50	1925	+ 3	−575	.177	110	1050	+35	−1450	.446
55	1820	+ 6	−680	.209					

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Table 17

RU-4A RECEIVER

FREQUENCY DRIFT

6200 Kcs. Decreasing Temperature

Single Coil

Time Min.	Freq. Cycles	Temp. °C.	Diff. Cycles	%	Time Min.	Freq. Cycles	Temp. °C.	Diff. Cycles	%
0	500	+23			90	2150	- 9.5	+6150	.099
5	300	+19	-200	.003	95	2500	-10.	+6500	.105
10	250	+15	-250	.004	100	2850	-10.5	+6850	.11
15	375	+11	-125	.002	105	3150	-11.	+7150	.115
20	675	+ 8	+175	.0028	110	3550	-11.5	+7500	.12
25	1080	+ 6	+580	.009	115	3700	-12.	+7700	.124
30	1550	+ 4	+1050	.016	120	3900	-12.5	+7900	.127
35	2160	+ 2	+1660	.026	125	4300	-13.	+8300	.134
40	2500	0	+2000	.032	135	4500	-13.5	+8500	.137
45	3000	- 1	+2500	.04	150	5000	-14.5	+9000	.145
						Reset to 1000			
50	3450	-2	+2950	.047	165	1400	-15.5	+9400	.151
55	3880	-3	+3380	.054	180	2000	-16.5	+10000	.161
60	4315	-4	+3815	.061	195	2480	-17.5	+10480	.169
65	5000	-5	+4500	.072	210	2665	-18.	+10665	.172
	Reset to 500								
70	850	-6	+4800	.078	225	2850	-18.5	+10850	.175
75	1000	-7	+5000	.08	240	3000	-19.5	+11000	.177
80	1400	-8	+5400	.087	255	3320	-20.	+11320	.182
85	1800	-9	+5800	.093					

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Table 18

RU-4 RECEIVER

FREQUENCY DRIFT

6200 Kcs. Decreasing Temperature

Dual Coil

Time Min.	Freq. Cycles	Temp. °C.	Diff. Cycles	%	Time Min.	Freq. Cycles	Temp. °C.	Diff. Cycles	%
0	-3000	+26			90	-1965	- 8.5	6950	.11
5	-3040	+20.5	40	.0006	95	-1639	- 9.	7260	.117
10	-2900	+16.	100	.0016	100	-1273	- 9.5	7625	.123
15	-2640	+12.	360	.0058	105	-1000	-10.	7900	.127
20	-2250	+ 9.	650	.010	110	- 700	-11.	8200	.132
25	-1800	+ 6.5	1100	.017	115	- 450	-11.5	8450	.136
30	-1280	+ 4.	1620	.026	120	- 160	-12.	8740	.141
35	- 750	+ 2.	2150	.034	130	+ 200	-12.5	9100	.147
40	- 200	+ 0.5	2700	.043	140	+ 735	-14.	9635	.155
45	+ 300	- 0.5	3200	.052	150	+ 950	-14.5	9850	.159
50	+ 800	- 1.5	3700	.06	160	+1350	-15.	10,250	.165
55	+1200	- 2.5	4100	.066	170	+1650	-15.5	10,550	.17
60	+1700	- 3.5	4600	.074	180	+2100	-16.5	11,000	.177
65	+2150	- 4.5	5050	.081	190	+2450	-17.	11,350	.183
70	+2600	- 5.5	5500	.089	200	+2675	-17.5	11,575	.187
75	+3000	- 6.	5900	.095	210	+2900	-18.	11,800	.19
	Reset to -3000								
80	-2700	- 7.	6200	.10					
85	-2300	- 7.5	6600	.106					

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Table 19

RU-4A RECEIVER

FREQUENCY DRIFT

6200 Kcs. Increasing Temperature

Single Coil

Time Min.	Freq. Cycles	Temp. °C.	Diff. Cycles	%	Time Min.	Freq. Cycles	Temp. °C.	Diff. Cycles	%
0	+3000	-28			61	-3000	+ 3.5	6000	.097
						Reset to +3000			
5	+2835	-27	165	.0026	65	+2400	+ 5.5	6600	.106
10	+2620	-23.5	380	.006	70	+1400	+ 8.5	7550	.122
15	+2255	-21	645	.01	75	+ 450	+12.	8550	.138
20	+1950	-20	1050	.017	80	- 600	+15.	9600	.155
25	+1615	-17	1385	.022	85	-1600	+17.5	10600	.171
30	+1110	-15	1890	.03	90	-2700	+20.5	11700	.188
35	+560	-12	2440	.039	92	-3000	+21.5	12000	.193
						Reset to +3000			
40	0	- 7.5	3000	.048	95	+2380	+23.5	12620	.204
45	- 775	- 8.5	3775	.061	100	+1350	+26.	13650	.22
50	-1400	- 6.	4400	.071	105	+ 450	+28.	14550	.243
55	-2000	0	5000	.08	110	- 475	+30.	15475	.25
60	-2800	+ 2	5800	.093					

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Table 20

GF-3 TRANSMITTER

POWER OUTPUT

ANTENNA RESISTANCE 20.6 OHMS

POWER SUPPLY 14 VOLTS

Kcs.		Ant. Amps.	Output Watts	Kcs.		Ant. Amps.	Output Watts
2950	CW	.89	16.31	6000	CW	.915	17.25
2950	MCW	.8	13.18	6000	MCW	.83	14.19
2950	Voice	.51	5.36	6000	Voice	.47	4.55
3250	CW	.89	16.31	6600	CW	.94	18.18
3250	MCW	.76	11.89	6600	MCW	.8	13.18
3250	Voice	.46	4.35	6600	Voice	.47	4.55
3650	CW	.9	16.69	7300	CW	.94	18.18
3650	MCW	.82	13.86	7300	MCW	.8	13.18
3650	Voice	.48	4.75	7300	Voice	.5	5.15
3675	CW	.9	16.69	7350	CW	.9	16.69
3675	MCW	.81	13.51	7350	MCW	.83	14.19
3675	Voice	.49	4.94	7350	Voice	.5	5.15
4025	CW	.92	17.43	8050	CW	.935	18.
4025	MCW	.81	13.51	8050	MCW	.845	14.71
4025	Voice	.49	4.94	8050	Voice	.49	4.94
4475	CW	.93	17.84	8950	CW	.955	18.80
4475	MCW	.78	12.52	8950	MCW	.8	13.18
4475	Voice	.48	4.75	8950	Voice	.49	4.94

Table 21

GF-3 TRANSMITTER

CURRENT VALUES

POWER SUPPLY 14 VOLTS

	OSC - AMP Plate & Screen Current			MODULATOR Plate & Screen Current		
	CW	MCW	Voice	CW	MCW	Voice
M.A.	147	116	110	9	7.8	14.4

Table 22

GF-3 TRANSMITTER

CURRENT VALUES

POWER DRAIN
ON
PRIMARY POWER SOURCE
(14 VOLTS)

	CW	MCW	Voice
Transmitter only	9.4A	8.55A	8.65A
Entire equipment	10.9A	9.9A	10.0A

Table 23

PERCENTAGE OF MODULATION

Input Freq. Cycles	3250 Kcs. .2 V (%)	.25 V (%)	.3 V (%)	Input for 100%	8050 Kcs. .2 V (%)	.25 V (%)	.3 V (%)	Input for 100%
100	45	52	54	.5(80%)	43	51	56	.5 (78%)
200	68	76	80	.32	67	77	85	.34
300	76	85	100+	.26	77	84	100+	.28
500	90	100+	100+	.22	84	100+	100+	.23
1000	100	100+	100+	.2	81	100+	100+	.21
2000	76	100+	100+	.23	77	88	100+	.26
3000	72	80	100+	.28	70	81	100	.3
5000	64	67	76	.36	63	70	81	.37

Table 24

GF-3 TRANSMITTER

AUDIO HARMONIC DISTORTION OF OUTPUT

3250 Kcs.

Freq. Cycles	Harmonics 2	3	4	5	6	7	8	9	%
100	3.	6.5	1.6	2.5	1.2	0	0	0	7.84
200	1.6	8.2	2.	.3	1.5	0	0	0	8.73
300	.8	10.2	2.	.8	.2	.3	0	2.5	10.75
500	.8	10.5	1.7	.72	.5	.2			10.68
1000	2.3	7.5	1.2						8.
2000	3.8	8.5	.6	.5					9.34
3000	4.5	4.	2.7	.3					6.6

Table 25

8050 Kcs.

Freq. Cycles	Harmonics 2	3	4	5	6	7	8	9	%
100	3.7	5.3	1.7	1.6					6.87
200	3.	10.	2.	.5	1.5				10.75
300	2.7	12.5	1.7	1.2	.2				12.95
500	2.5	11.8	1.6	2.	.7				12.34
1000	4.	8.6	1.3						9.58
2000	7.	6.5	1.0	.4	.2	.2	.3		9.62
3000	7.8	6.	3.3	.5					10.38

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Table 26

GF-3 TRANSMITTER

FREQUENCY DRIFT

3500 Kcs.

Time Minutes	Temperature °C.	Frequency Cycles	Time Minutes	Temperature °C.	Frequency Cycles
0	-26.	0	65	+19.	2000
5	-25.5	850	70	+22.5	2100
10	-24.	950	75	+25.	2200
15	-23.	1000	80	+28.	2300
20	-20.	1075	85	+29.5	2350
25	- 9.5	1125	90	+32.5	2450
30	- 3.	1200	95	+24.5	2525
35	+ 1.	1275	100	+36.	2575
40	+ 4.5	1400	105	+38.	2650
45	+ 8.	1500	110	+39.5	2700
50	+12.	1650	120	+43.5	2800
55	+14.5	1775	130	+47.	2875
60	+17.	1900	140	+49.5	3000

Total drift - 3000 cycles
Per cent total drift - .085

Drift over 50.5° after first five minutes - 1350 cycles
Per cent drift over 50.5° after first five minutes - .038

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Table 27

GF-3 TRANSMITTER

FREQUENCY DRIFT

4000 Kcs.

Time Minutes	Temperature °C.	Frequency Cycles	Time Minutes	Temperature °C.	Frequency Cycles
0	-26.	0	48	+15.	1350
3	-25.5	500	53	+17.5	1475
8	-24.	700	63	+22.	1675
13	-14.5	725	73	+28.	1900
18	- 8.5	700	83	+31.5	2000
23	- 2.5	750	93	+36.5	2150
28	+ 1.5	850	103	+39.	2250
33	+ 6.5	1000	113	+42.	2350
38	+ 9.5	1100	123	+46.	2500
43	+12.	1200	133	+50.	2600

Total drift - 2600 cycles
Per cent total drift - .065

Drift over 53.5° after first three minutes - 1400 cycles
Per cent drift over 53.5° after first three minutes - .035

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Table 28

GF-3 TRANSMITTER

FREQUENCY DRIFT

6500 Kcs.

Time Minutes	Temperature °C.	Frequency Cycles	Time Minutes	Temperature °C.	Frequency Cycles
0	-27.	0	73	+26.5	3100
3	-27.	900	78	+28.5	3150
8	-25.5	1500	83	+31.5	3250
13	-17.5	1600	88	+33.5	3400
18	- 8.	1500	93	+35.	3500
23	- 2.	1800	98	+36.5	3625
28	+ 2.	1900	103	+38.	3725
33	+ 5.5	2050	108	+40.5	3825
38	+ 8.	2350	113	+43.	3950
43	+11.5	2450	118	+44.	4150
48	+14.5	2850	123	+45.5	4250
53	+17.	2800	128	+48.	4250
58	+19.5	2875	133	+49.	4350
63	+21.5	2925	138	+50.	4400
68	+24.5	3000			

Total drift - 4400 cycles
Per cent total drift - .067

Drift over 51.5° after first three minutes - 2100 cycles
Per cent drift over 51.5° after first three minutes - .032

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Table 29

GF-3 TRANSMITTER

FREQUENCY DRIFT

8000 Kcs.

Time Minutes	Temperature °C.	Frequency Cycles	Time Minutes	Temperature °C.	Frequency Cycles
0	-26	0	60	+22.5	4000
5	-25	1600	65	+26	4200
10	-25.5	1725	70	+27.5	4325
15	- 9	2000	75	+29	4450
20	- 3	2250	80	+32	4625
25	+ 2	2450	85	+34	4750
30	+ 5	2750	90	+36	4900
35	+ 8	2950	95	+39	5000
40	+12	3200	100	+41	5250
45	+15	3425	105	+42.5	5375
50	+18	3650	110	+46.5	5450
55	+20	3850			

Total drift - 5450 cycles
Per cent total drift - .068

Drift over 51° after first five minutes - 2600 cycles
Per cent drift over 51° after first five minutes - .032

Table 30

GF-3 TRANSMITTER

RESET MEASUREMENTS

Assigned Frequency Kcs.	Measured Frequency Kcs.	Reset Frequency Kcs.	Frequency Difference Cycles	%
3475	3477.64	3477.86	220	.006
4135	4139.28	4137.54	1740	.044
6690	6686.88	6688.07	1190	.019
8270	8259.96	8260.58	620	.0074

Table 31

SIZES AND WEIGHTS

	Actual	Allowable
Transmitter		
Weight	11 lb. 2 oz.	12 lb.
Length	13-1/4 in.	13-1/4 in.
Width	6-7/8 in.	6-5/8 in.
Height	6-3/8 in.	6-3/8 in.
Mounting Base		
Weight	9 oz.	10 oz.
Length	13-1/4 in.	13-1/2 in.
Width	6-1/4 in.	6-1/2 in.
Height	1-3/4 in.	1-3/4 in.
Transmitter Control Box		
Weight	12 oz.	12-3/4 oz.
Length	5-1/16 in.	5-1/2 in.
Width	3-7/8 in.	4-1/8 in.
Height	2-3/8 in.	2-3/8 in.
Extension Control Box		
Weight	11 oz.	11-1/4 oz.
Length	5-1/16 in.	5-1/2 in.
Width	3-7/8 in.	4-1/8 in.
Height	2-3/8 in.	2-3/8 in.

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Table 32

SIZES AND WEIGHTS

	Actual	Allowable
Junction Box		
Weight	2 lbs.	2 lbs.
Length	7-3/8 in.	7-3/8 in.
Width	5-1/2 in.	5-1/2 in.
Height	2-3/4 in.	2-11/16 in.
Dynamotor Unit		
Weight	13 lbs. 9 oz.	14 lb.
Length	9-1/2 in.	9-1/2 in.
Width	5-5/8 in.	5-3/8 in.
Height	6-3/16 in.	6 in.
Receiver		
Weight	12 lbs. 12 oz.	12 lbs. 14 oz.
Length	16-1/2 in.	15 in.
Width	7-3/8 in.	7-1/4 in.
Height	7-11/16 in.	6-1/2 in.
Receiver Mounting Base		
Weight	10 oz.	10 oz.
Length	15-1/2 in.	15-11/16 in.
Width	6-1/4 in.	6-1/4 in.
Height	1-3/4 in.	1-3/4 in.

Table 33

Receiver Switch Box		
Weight	13 oz.	13 oz.
Length	5-1/16 in.	5-1/2 in.
Width	3-5/8 in.	4-1/8 in.
Height	2-3/8 in.	2-3/8 in.
Receiver Remote Tuning Control and Mechanical Linkage		
Weight (tuning control)	14 oz.	1 lb.
Depth " "	2-1/2 in.	2-5/8 in.
Width " "	3 in.	3 in.
Height " "	5-3/4 in.	6 in.
Weight (mechanical linkage)	1 lb. 3 oz.	1 lb. 12 oz.
Length " "	10 ft.	10 ft.
Receiver Local Tuning Control		
Weight	1 oz.	3 oz.
Antenna Relay Unit		
Weight	14 oz.	12.8 oz.
Length	5-1/16 in.	5-1/16 in.
Width	3-1/8 in.	3-1/8 in.
Height	2-3/4 in.	2-11/16 in.

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Table 34

SIZES AND WEIGHTS

		Actual	Allowable
Connecting Cables			
Cable 121	Weight	1 lb. 2 oz.	15 oz.
	Length	6 ft.	6 ft.
Cable 233	Weight	1 lb. 4 oz.	15 oz.
	Length	6 ft.	6 ft.
Cable 134	Weight	13 oz.	9 oz.
	Length	4 ft.	4 ft.
Cable 135	Weight	14 oz.	9 oz.
	Length	4 ft.	4 ft.
Cable 236	Weight	1 lb. 5 oz.	15 oz.
	Length	6 ft.	6 ft.
Cable 37	Weight	14 oz.	9 oz.
	Length	4 ft.	4 ft.
Cable 175	Weight	10 oz.	1 lb. 2-1/2 oz.
	Length	2 ft.	7 ft.
Cable 77	Weight	8 oz.	15 oz.
	Length	6 ft.	6 ft.
Cable 80	Weight	1 lb. 2 oz.	15 oz.
	Length	6 ft.	6 ft.

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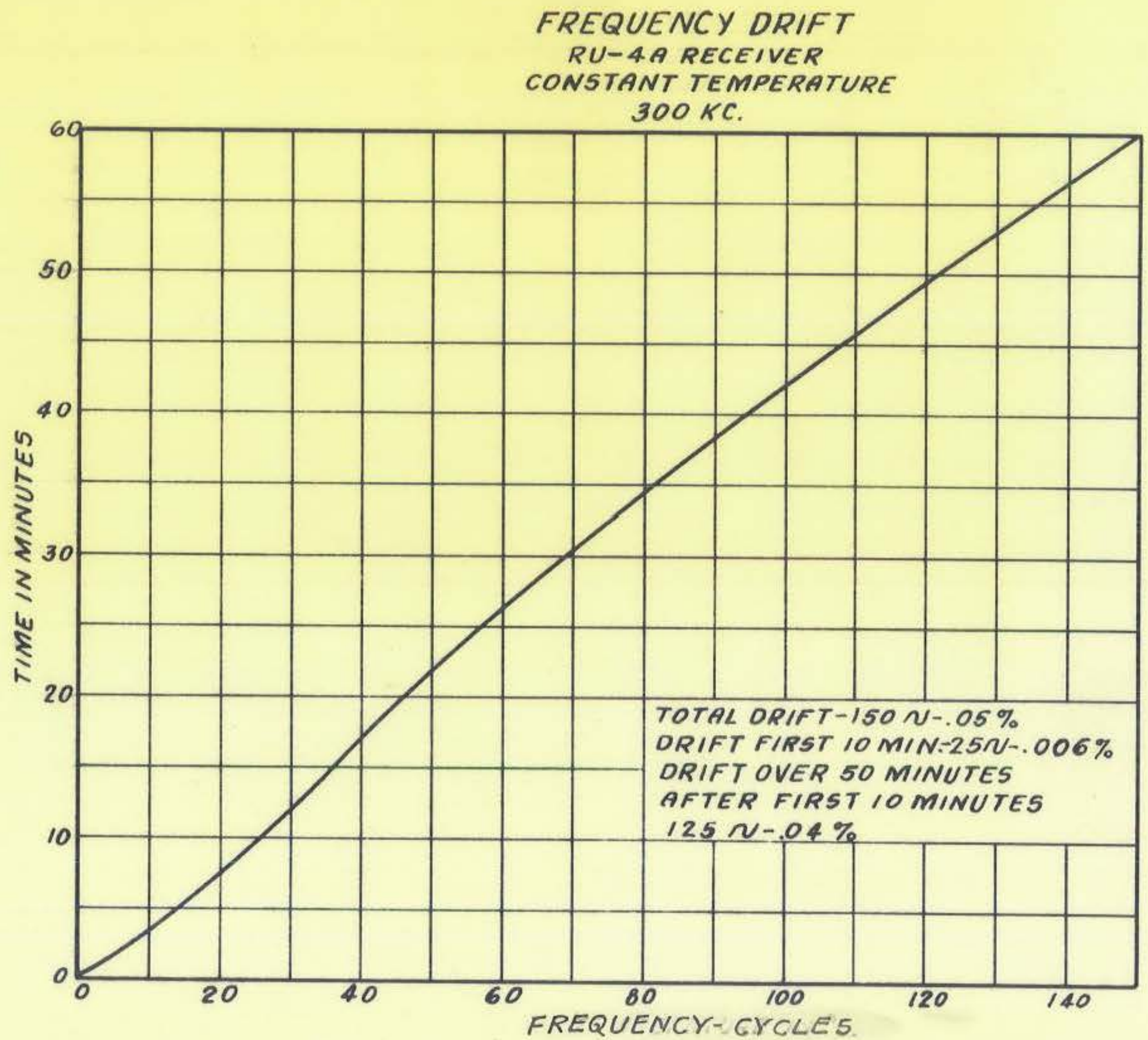

FREQUENCY DRIFT
RU-4A RECEIVER
CONSTANT TEMPERATURE
300 KC.
TIME IN MINUTES
0
10
20
30
40
50
60
0
20
40
60
80
100
120
140
FREQUENCY - CYCLES
TOTAL DRIFT - 150 ~ - .05%
DRIFT FIRST 10 MIN - 25 ~ - .006%
DRIFT OVER 50 MINUTES
AFTER FIRST 10 MINUTES
125 ~ - .04%

PLATE I

FREQUENCY DRIFT
RU-4A RECEIVER
CONSTANT TEMPERATURE
6000 KC.

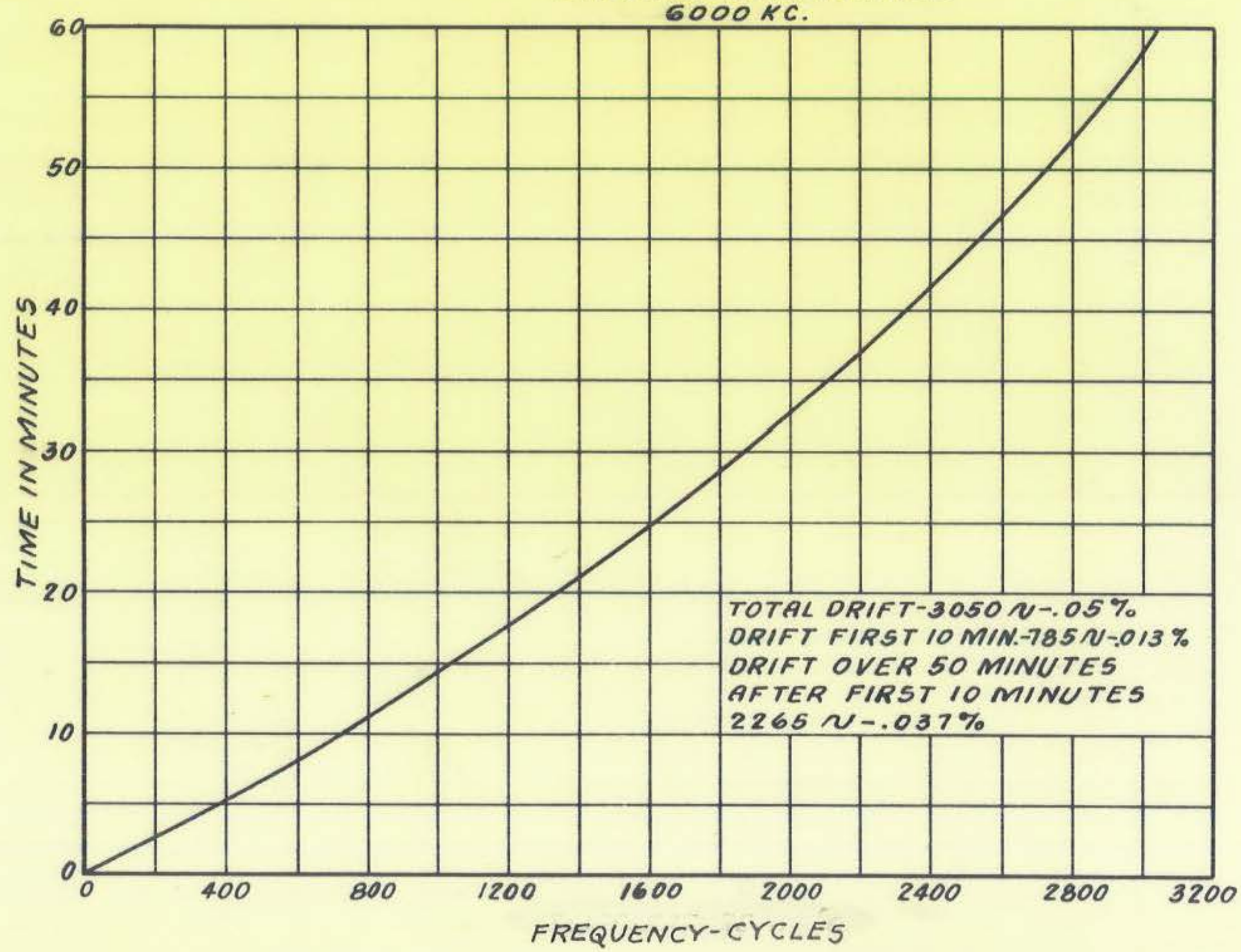


PLATE 2

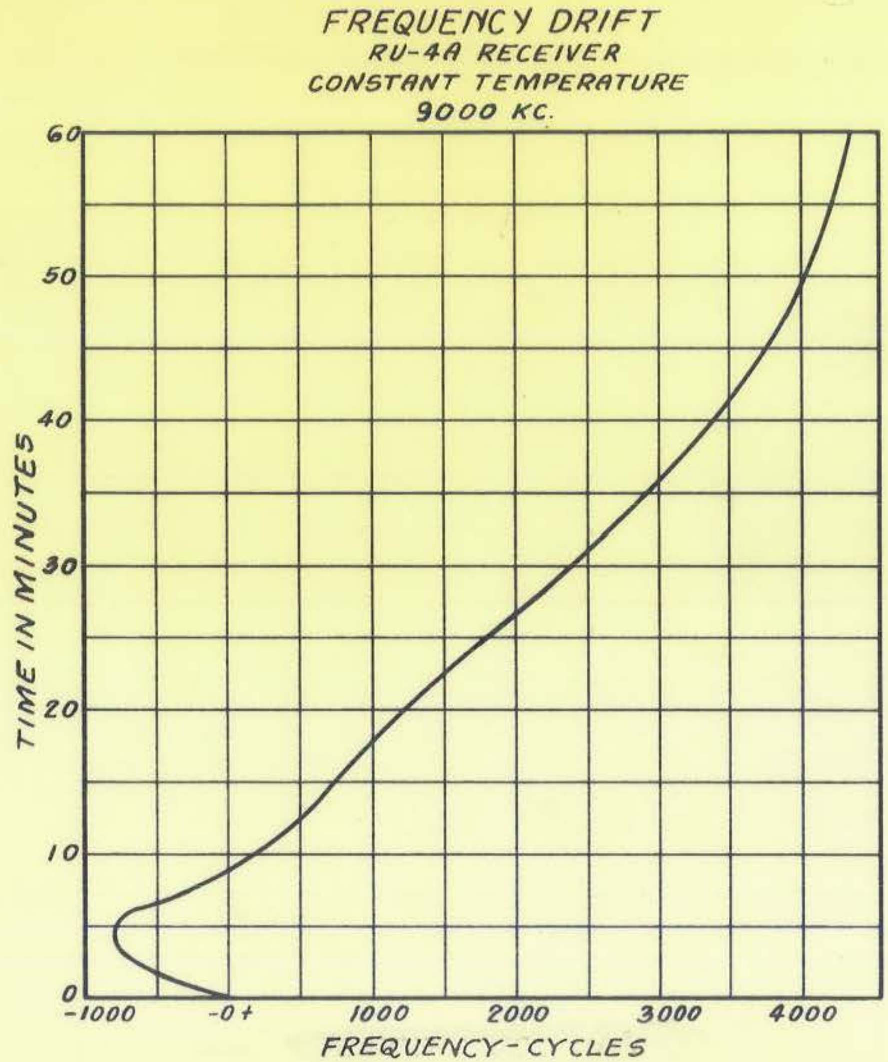

FREQUENCY DRIFT
RU-4A RECEIVER
CONSTANT TEMPERATURE
9000 KC.
60
50
40
30
20
10
0
TIME IN MINUTES
-1000
-0+
1000
2000
3000
4000
FREQUENCY-CYCLES

PLATE 3

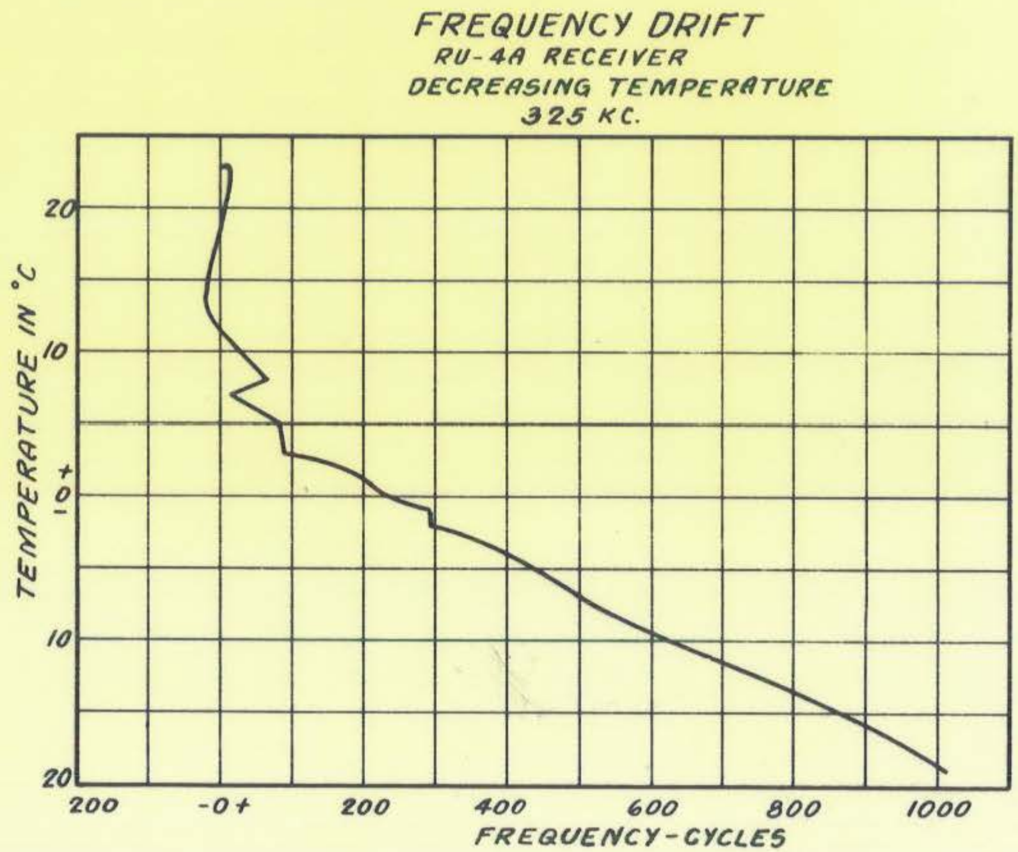

FREQUENCY DRIFT
RU-4A RECEIVER
DECREASING TEMPERATURE
325 KC.
TEMPERATURE IN °C
20
10
+
0
-
10
20
200
-0+
200
400
600
800
1000
FREQUENCY-CYCLES

PLATE 4

FREQUENCY DRIFT
RU-4A RECEIVER
INCREASING TEMPERATURE
325 KC.

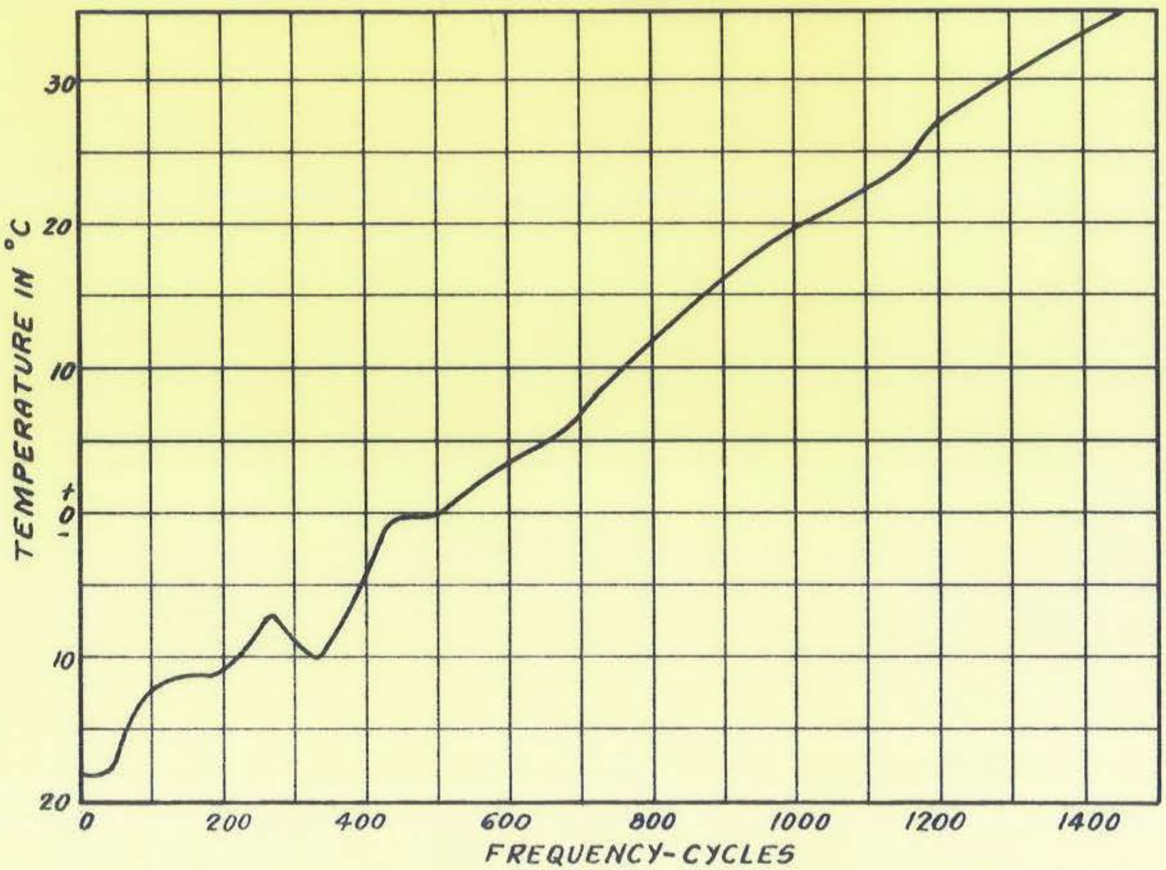


PLATE 5

FREQUENCY DRIFT
RU-4A RECEIVER
DECREASING TEMPERATURE
6200 KC. SINGLE COIL

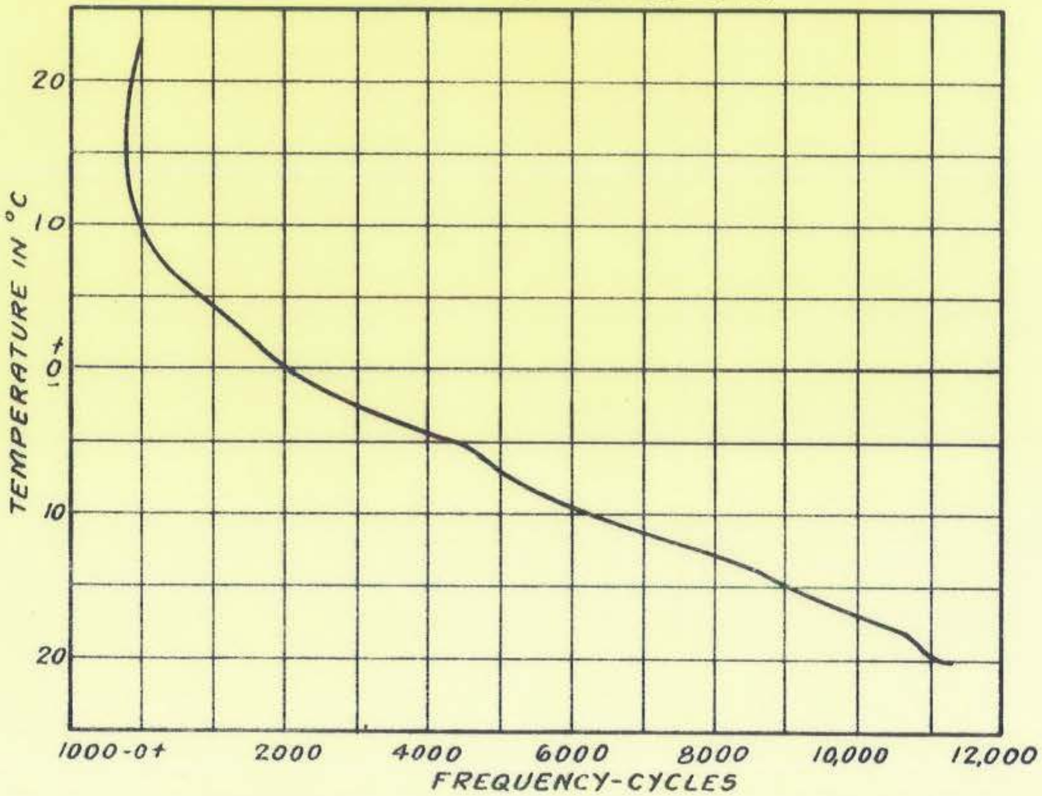


PLATE 6

FREQUENCY DRIFT
RU-4A RECEIVER
DECREASING TEMPERATURE
6200 KC. DUAL COIL

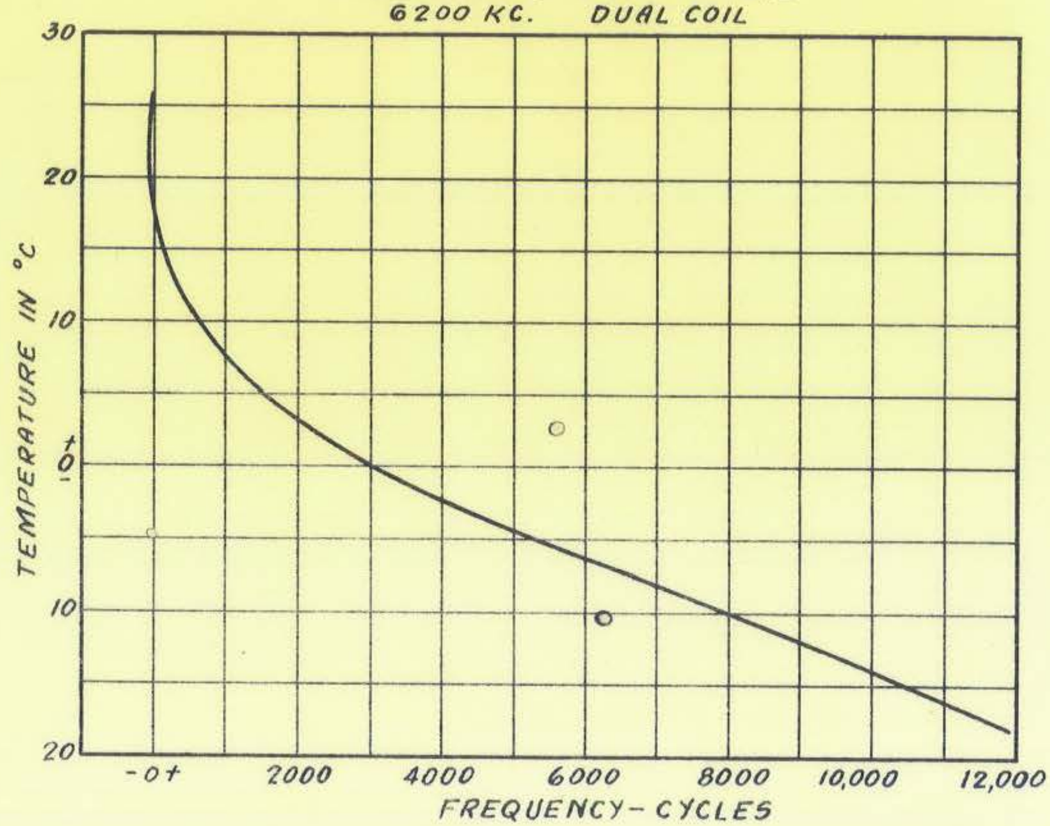


PLATE 7

FREQUENCY DRIFT
RU-4A RECEIVER
INCREASING TEMPERATURE
6200 KC. SINGLE COIL

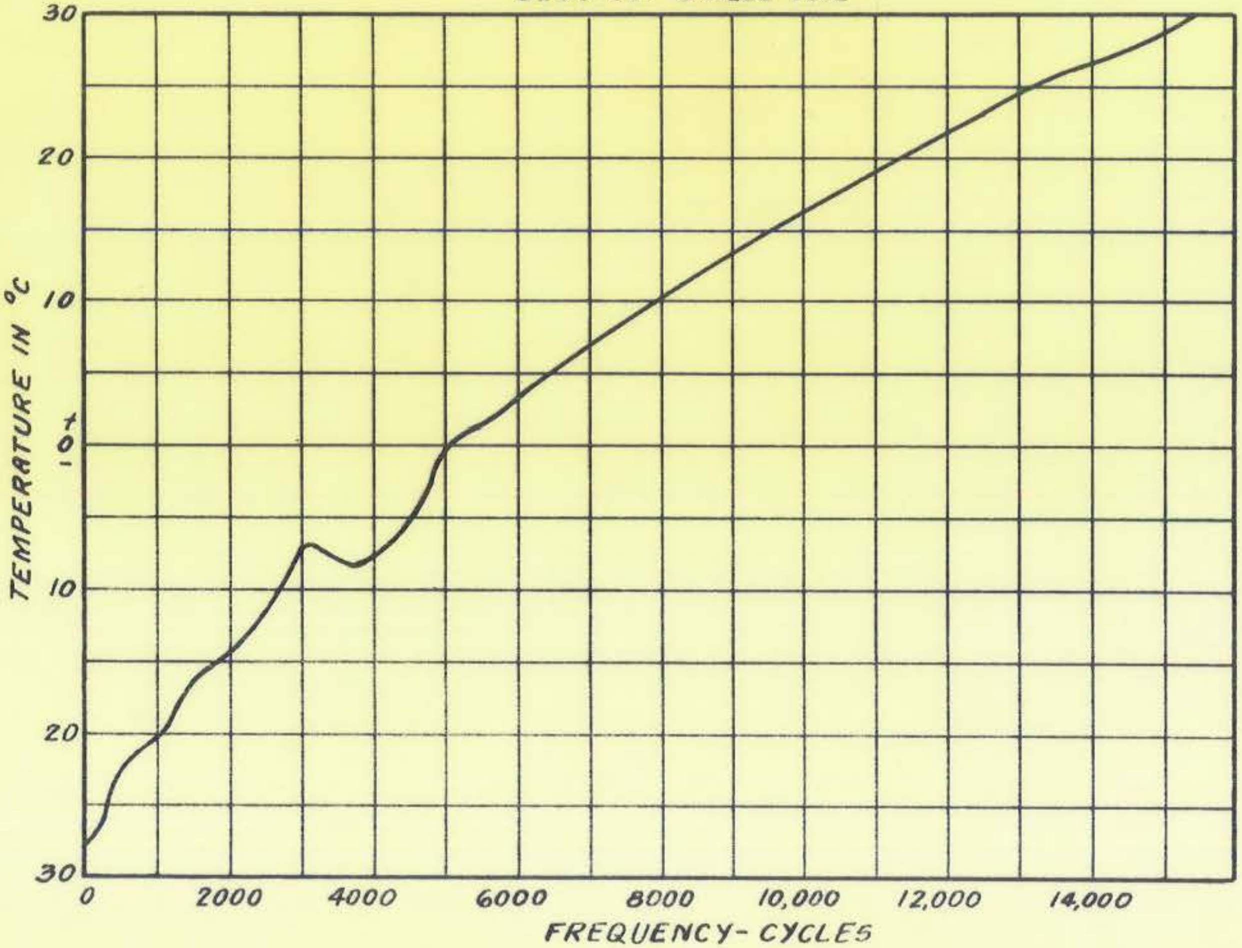
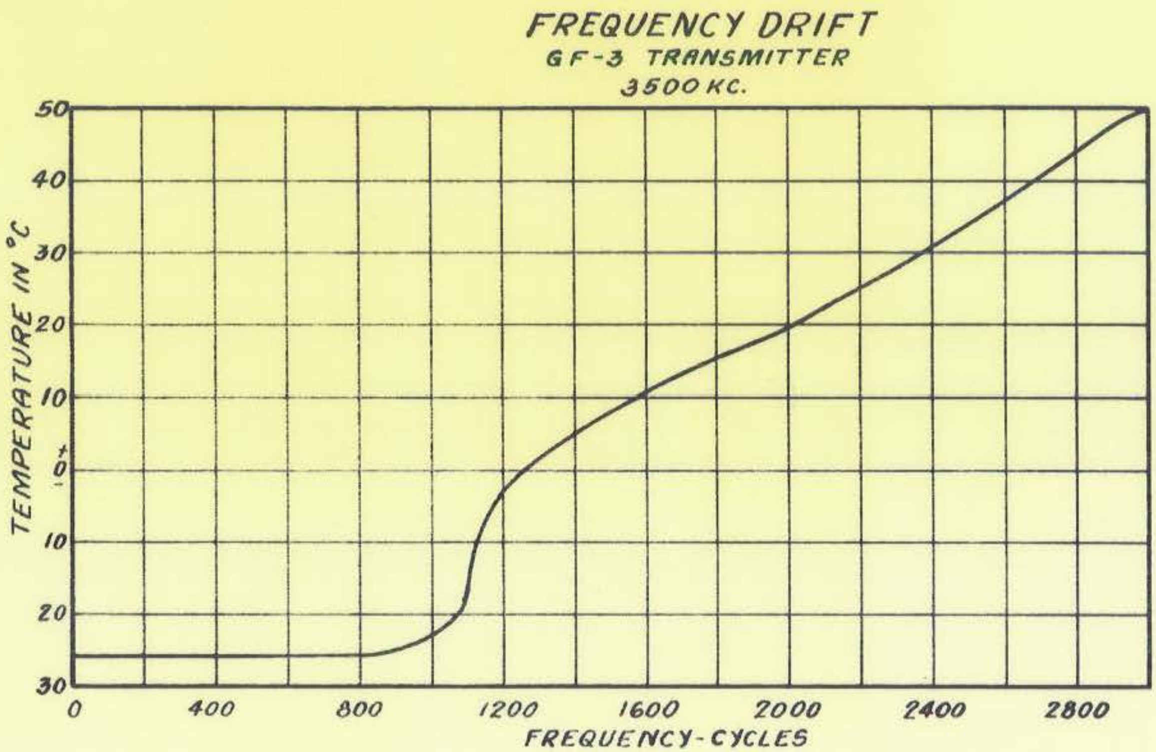


PLATE 8



FREQUENCY DRIFT
GF-3 TRANSMITTER
3500 KC.
TEMPERATURE IN °C
50
40
30
20
10
+
0
-
10
20
30
0
400
800
1200
1600
2000
2400
2800
FREQUENCY-CYCLES

PLATE 9

FREQUENCY DRIFT
GF-3 TRANSMITTER
4000 KC.

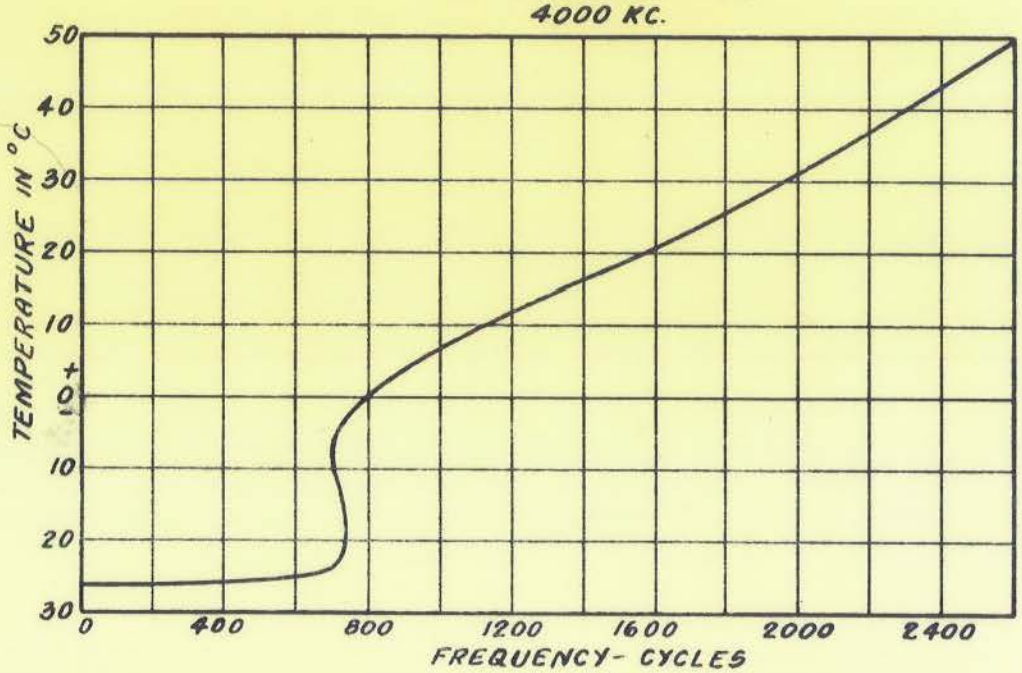


PLATE 10

FREQUENCY DRIFT
GF-3 TRANSMITTER
6500 KC.

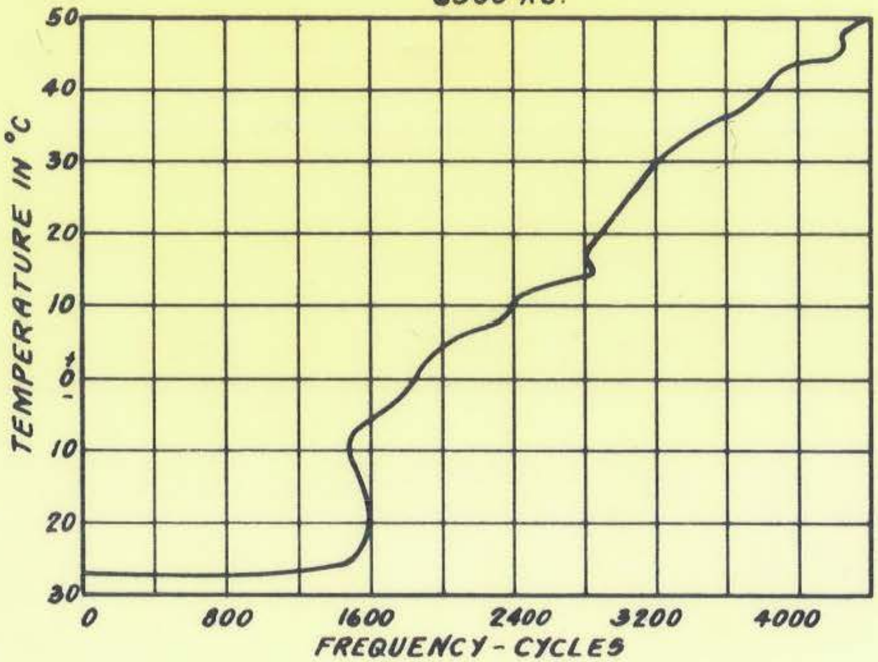


PLATE II

FREQUENCY DRIFT
GF-3 TRANSMITTER
8000 KC.

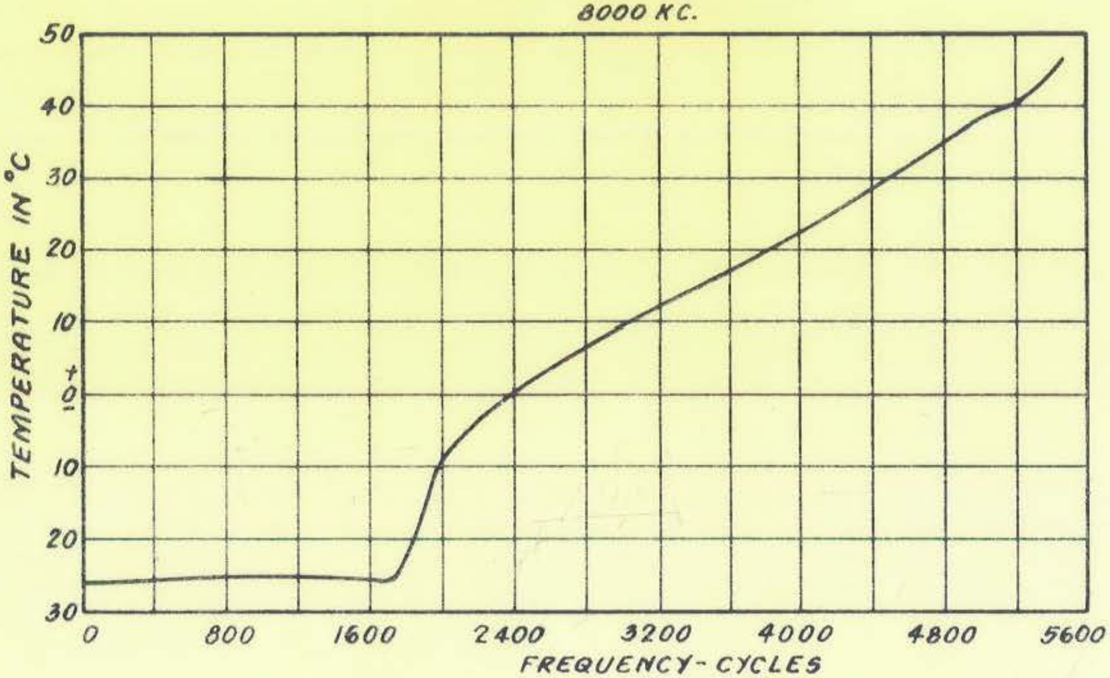


PLATE 12

[redacted]

MODEL GF-3 EQUIPMENT
MODULATION PHOTOGRAPHS
3250 KCS.

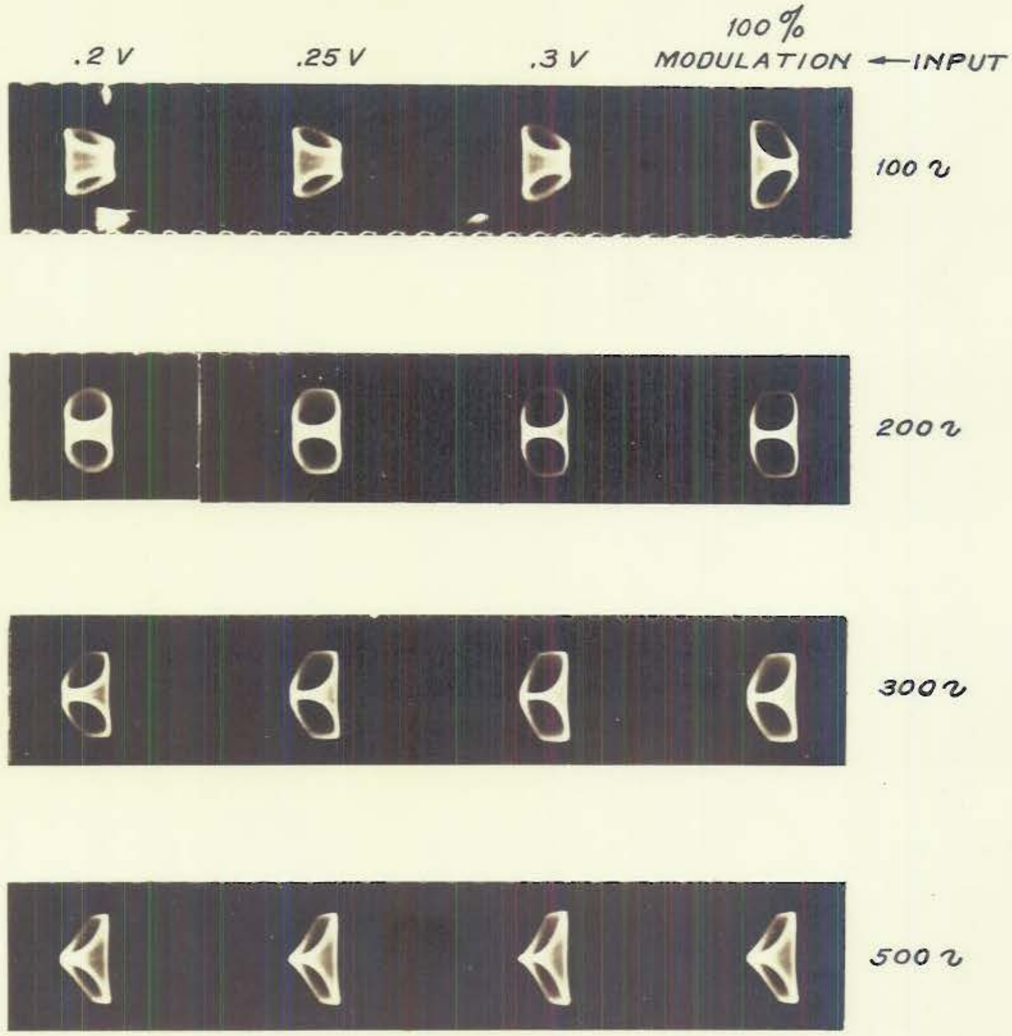


PLATE 13

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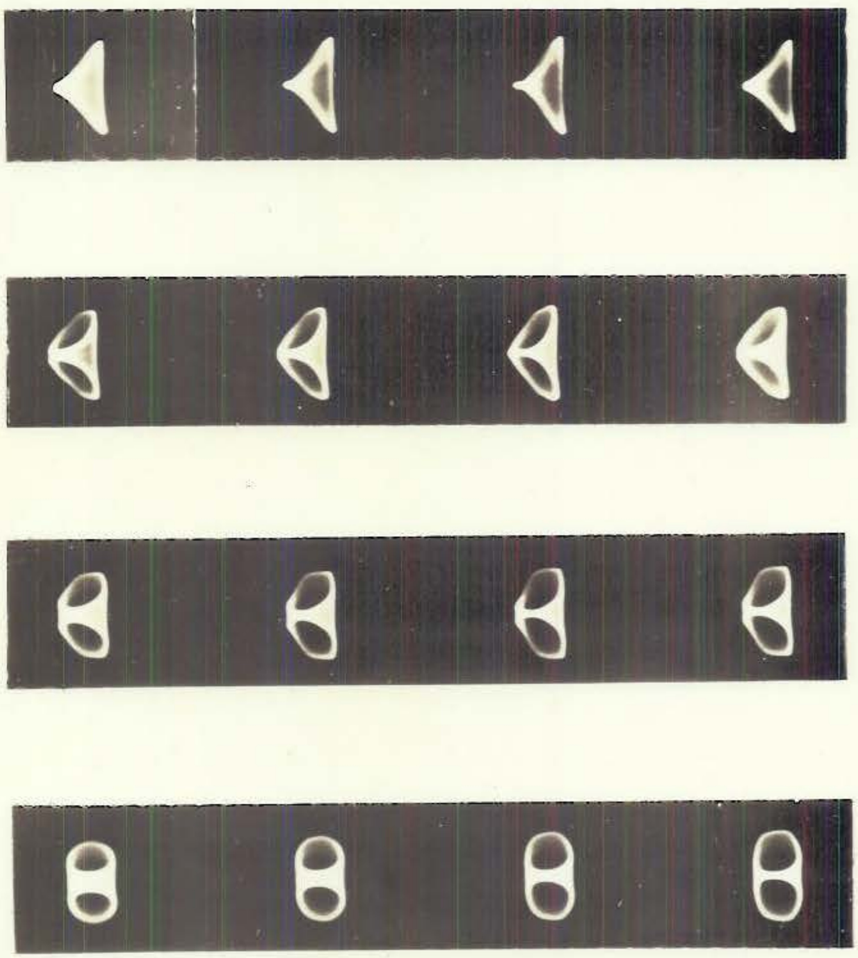
MODEL GF-3 EQUIPMENT
MODULATION PHOTOGRAPHS
3250 KCS.

.2 V | .25 V | .3 V | 100% MODULATION ← INPUT

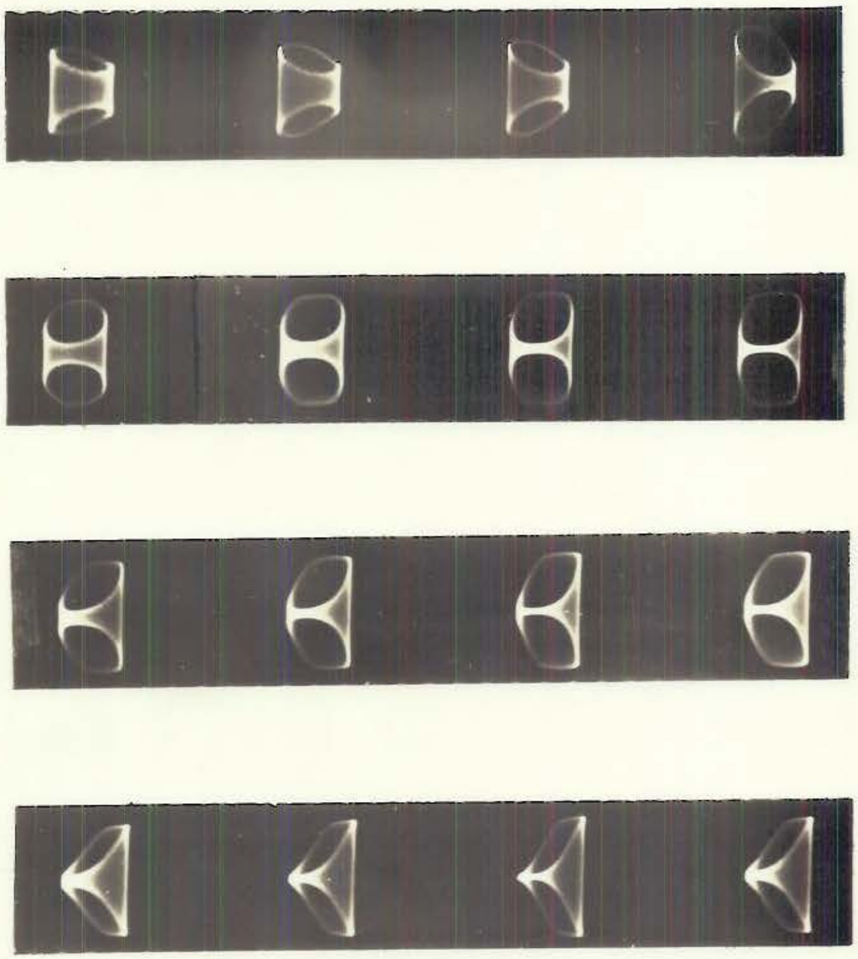


1000 ~
2000 ~
3000 ~
5000 ~

PLATE 14

MODEL GF-3 EQUIPMENT
MODULATION PHOTOGRAPHS
8050 KCS.

.2 V | .25 V | .3 V | 100 % MODULATION ←— INPUT



100 ~

200 ~

300 ~

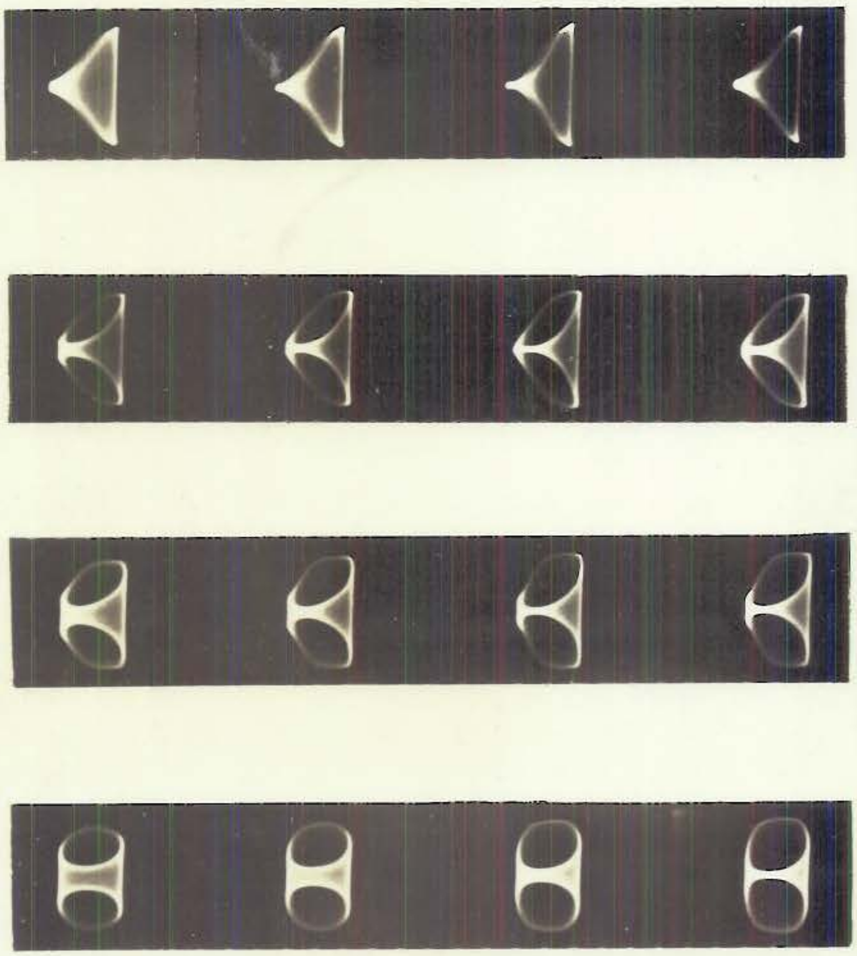
500 ~

PLATE 15

[redacted]

MODEL 6F-3 EQUIPMENT
MODULATION PHOTOGRAPHS
8050 KCS.

.2 V | .25 V | .3 V | 100 % MODULATION ⟵ INPUT



1000 ~

2000 ~

3000 ~

5000 ~

PLATE 16

CONFIDENTIAL

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

(CONFIDENTIAL)
F42-1/NA6 (204)
(Serial 36099)

July 24, 1936.

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

Subject: Aircraft Radio - Model GF-3 Aircraft Radio Equipment - Report on Flight Tests of.

Reference: (a) N.R.L. ltr., F42-1/43, of 25 March 1936.
(b) Memorandum report of BuEng. Conference held 1 April 1936, constituting Enclosure (A) of BuEng. ltr., NOs-42945 (4-3-W3) dated 11 April 1936.
(c) Memorandum report of BuEng. Conference held 23 April 1936, constituting Enclosure (A) of BuEng. ltr., NOs-42945 (4-24-W3) dated 2 May 1936.
(d) N.A.S., Anacostia, ltr., F42-1/NA6 (106) of 4 May 1936, to N.R.L.
(e) BuAero. Installation Specification No. 52-B for Model GF Series Radio Equipment.

Enclosure: (A) N.A.S., Anacostia, Memorandum for BuEng. Conference on GF-3 Equipment, dated 1 April 1936.

1. A complete sample equipment, Model GF-3, (including model RU-4A receiving equipment), was received from Naval Research Laboratory on 27 February 1936 for tests in accordance with reference (a). It was given preliminary operating tests in the laboratory and then installed in O3U-2 airplane No. 8810. After ten flights aggregating approximately nine hours, a conference, reported in reference (b), was held at the Bureau of Engineering, after which the equipment was removed from the airplane and returned to the Contractor for certain alterations.

2. After incorporation of changes and discussion of these features at a Bureau of Engineering conference, as reported in reference (c), the altered equipment was returned to this station on 24 April 1936, accompanied by a representative of the Contractor. It was successively installed in XSBF-1 airplane No. 9996 and in O3U-2 airplane No. 8810, and in these two installations tested on eleven flights, bringing the total flight test time up to about 22 hours. After further laboratory examination and operating tests, the equipment was returned to the Naval Research Laboratory on 29 May 1936.

3. The sample Model GF-3 equipment, as originally received, was practically identical with the Model GF-2 equipment reported upon in reference (d), and was found open to a number of criticisms listed in Enclosure (A). After incorporation of the changes described under reference (c), the operating characteristics were found to be considerably

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improved, especially for two-seat installations.

4. With respect to the tests requested in paragraph 2 of reference (a), the following results were obtained or conclusions reached:

(a) Except for the fact that some of the cable lengths supplied were not in agreement with those specified under reference (e), the complete equipment was found adaptable for installation in all single and two seat fighting planes, and other types of naval aircraft. Both a model LJ and a preliminary model LM frequency meter gave satisfactory operation in connection with the GF-3 installation.

(b) Transmitter and receiver operated satisfactorily, on all types of emission or reception, both on fixed and on trailing wire antennae not exceeding fifty feet in length. The lack of an internal series condenser requires that the antenna be operated below its own quarter (or three quarter) wave fundamental frequency; at frequencies above approximately 6500 kcs this prevents use of a full "Vee" fixed antenna of the dimensions required by standard model GP equipment, but the active length of such antennae are easily shortened to raise their fundamental frequency above the required operating frequencies.

(c) Observations on the flight re-set accuracy of the GF-3 transmitter, both without and with either model LJ or LM frequency meter, were made directly at the Naval Research Laboratory.

(d) Satisfactory break-in communication on CW and MCW was obtained with the receiver on manual volume control. Telegraphic two-way communication was satisfactory at a distance of 75 miles, in communication with another airplane provided with a GF-2 installation. Plane-to-plane voice communication was found practicable up to fifty miles, under varying atmospheric conditions.

(e) Satisfactory output was obtained on the specified antennae, as long as the fundamental frequency of the antenna used did not closely approach, nor fall below, the highest employed transmitting frequency. The output tuning characteristics of the equipment are considered satisfactory.

(f) The receiver operates satisfactorily both on antenna and loop, without re-tuning, but generally requires readjustment

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F42-1/NA6 (204)
(Serial 36099)

NAS ANACOSTIA, D.C.

Subject: Aircraft Radio - Model GF-3 Aircraft Radio Equipment - Report on Flight Tests of.

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of the antenna trimming condenser when shifting from one to the other. No specific improvement can be suggested, except continuing the service practice of matching the loop to the antenna trimming around the most important frequency used for homing. It should be noted that modern types of direction finding equipment do not employ the "Loop" binding posts, but attach directly to the antenna terminal without need for retrimming for direction finding use.

(g) No readjustment of trimming condensers was found necessary after changing receiver coils, as long as the same antenna was employed.

(h) With a trailing wire antenna not exceeding fifty feet in length, direction finding on a standard loop was satisfactory without reeling in the antenna. A trailing antenna one hundred feet or more in length prevented satisfactory direction finding.

(i) The intercommunication system of the altered GF-3 equipment was found very satisfactory in flight. The telegraphic side tone is considered louder than desirable. For operation in single seat airplanes, all side tone levels are considered excessive.

(j) Tuning or sensitivity control variations were found not to affect indicated radio bearings.

4. When using a type NEA-1A or NEA-2 engine driven generator, an 800 cycle background ripple was noticed during voice transmission, but not of sufficient strength to impair intelligibility of speech.

5. The following ICS and side tone levels were measured in normal flight operation, across 600 ohm headsets, with receiver on MVC at full gain, and pilot's control on full volume:

Signal Measured:	2-Seat Installation, Volts, r.m.s.	1-Seat Installation, Volts, r.m.s.
MCW side tone	10.5 v.	15.0 v.
CW side tone	10.5 v.	15.0 v.
Voice side tone (peaks)	7.0 v.	9.0 v.
ICS Mixed, Voice peaks	7.0 v.	---
ICS Clear, Voice peaks	9.0 v.	---

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(Serial 36099)

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6. As noteworthy features of the subject equipment, this station points out the continued high grade of workmanship and attention to design details by this Contractor, and the successful changes improving the subject equipment over the GF-2 in the following respects:

(a) Neither microphone is active except while throttle switch or switch on microphone is depressed.

(b) A special design of jack enables using microphone switch button in "locked" position, without internal alterations, for control by throttle switch; in this condition, the microphone does not mix picked-up noise with reception.

(c) In addition to "mixed" ICS superposed on reception, auxiliary "clear channel" ICS is provided, controlled by the operator through a fool-proof hold-down switch.

(d) Both occupants have individual selection between ICS and Radio transmission.

(e) Except at highest receiver gain, the received signal provided for the pilot, due to his generally noisier location, has twice the volume of the signal strength chosen by the operator for himself, when on MVC. The pilot may reduce his own signal as he desires, by means of his own volume control. On AVC, each occupant has full individual control of his own headset level.

(f) The restoration time of the receiver, on MVC, has been speeded up for satisfactory break-in operation.

(g) Suitable dummy plugs for the junction box outlets have been designed to enable retention of the throttle switch in single-seat installations, and of ICS together with dual volume control when installed without the transmitter unit.

(h) The provisions for heterodyne frequency meter operation are now satisfactory both for transmitter and receiver adjustment. Monitoring of the transmitted frequency by the receiver is not possible, however, due to dynamotor limitations.

7. In production of the subject equipment, discrepancies between actual cable lengths and those specified in reference (e) should be avoided. The most important remaining improvements still to be desired in the subject equipment are the provision of a side-tone differential decreasing the telegraphic side tone well below the speech side-tone level, and, for single-seat installations only, a general reduction of all side-tone levels. Improved visibility of the output condenser tuning dial, from the front end of the transmitter unit, remains very desirable especially for two-seat installations.

(CONFIDENTIAL)
F42-1/NA6 (204)
(Serial 36099)

NAS, ANACOSTIA, D.C.

Subject: Aircraft Radio - Model GF-3 Aircraft Radio Equipment - Report on Flight Tests of.

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8. The subject equipment represents a definite advancement over comparable apparatus in present use, and especially if the additional changes suggested above can be incorporated, should prove highly satisfactory for service use on various types of naval aircraft.

9. For purposes of information and reference it is requested that this station be furnished two (2) copies of the Laboratory's final report on the subject equipment, when issued.

(Signed) V.C. Griffin.

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cc: BuAero (2)
BuEng. (1)
N.A.F. (1)

N.A.S. Anacostia,
Radio Test Section,
1 April 1936.

Memorandum for Conference on GF-3 Equipment.

Note: The following suggestions are based upon general experience with GF-2 equipment, and laboratory inspection and general examination of GF-3 apparatus; the recent flood at Anacostia has prevented flight testing the GF-3 equipment, to date.

The outstanding difficulty with this equipment, when installed in torpedo, bombing, or similar planes carrying operators, is ready shifting of frequency of the transmitter in flight; likewise, frequency setting should be facilitated on single seaters where frequently a single radioman has an entire squadron to look after and to check up or re-tune before leaving carrier deck.

The following suggestions are offered to stimulate discussion and to point out what might be done to increase the universal utility of the subject equipment, if feasible in the present stage of evolution:

Transmitter Unit:

a. Provide crank on output tuning condenser, similar to local tuner control for receiver. (30 turns at present required).
b. Provide roughly graduated tuning indicator (dial or pointer) on output tuning condenser, to avoid groping in the dark on condenser setting or direction for increase and decrease.
c. Provide graduated scale strips (counting coupling turns beginning from Ground end) on each output coil sliding tap mount. Radioman can't count turns readily when re-tuning under flight vibration.
d. Provide blank Master Calibration Chart (engraved on dull white celluloid) on front of transmitter unit, for rapid reference in shifting between assigned frequencies.
e. Investigate whether practicable to separate thermo-couple from present R.F. meter, and by means of built-in push button use same meter as (P.A.) plate milliammeter, for rapid and accurate tuning. Plate meter especially essential when operating h.f. on trailing antenna harmonic.

Junction Box:

f. Power outlet for frequency meter is still inoperative while transmitter is ON, absolutely preventing transmitter freq. check both by freq. meter and by receiver monitor method. Recommend this outlet remain LIVE at all times. Series resistor may be inserted for voltage reduction, but to avoid power loss the probably desirable associated bleeder resistor might be incorporated in the interconnecting unit (LM) on the load side of suitable ON-OFF switch.

ENCLOSURE (A)
(Confidential)

Instruction Book:

g. Suggest using "uncoated" paper (like GO books) for water res.
h. Circuit has gotten complicated. Add simplified schematic diagrams to clear up function and coordination of equipment.
i. Suggest representing transmitter cathodes conventionally (not as "plates") in diagram.
j. Retain margins of diagrams etc. clear of right edge of book; several diagrams in GF-2 book creep in too far.
k. Suggest adding typical antenna lengths for 3/4 wave radiation to table in text.

Cables:

l. Cable assortments, "tailored" to various planes in length, may be desirable.
m. Make throttle switch cable for F3F-1 planes, 110 inches long.

Accessories:

n. Discontinue supplying antenna material.
o. Discontinue supplying throttle switches.
p. Supply suitable test milli-ammeters.
q. Initiate supply of new microphones in which the push button normally will not lock closed, but where either one or both switch contacts may be locked or jumpered internally.

Control Boxes:

r. Add key jack to each transmitter and extension control box.
s. Consider combining, in one unit, the GF-3 receiver switch box and the transmitter control box; this will save space or enable further circuit evolution, and simplify installation mockup, as well as gain dependability of interconnections.

Correlation of Operation:

t. Reduce unblocking time on MVC, like RU-4.
u. Avoid volume control affecting pre-adjusted ICS and side tone level.
v. Enable either occupant to switch himself from radio to ICS.
w. Enable pilot, at will, to obtain stronger radio signal than operator.
x. Enable use of locked contact on microphone, with throttle switch control, by pilot both for radio and ICS.
y. During ICS conversation, but only while push button or throttle switch is pressed, leave receiver dead, or at least greatly weakened; receiver in normal sensitivity interfers greatly with ICS intelligibility. Present system is good in this respect, except that push-button and not ICS switch should control receiver cut-out. Additional relay may be required, possibly located in larger combined control box suggested under item (s).

P.2 ENCLOSURE (A)
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