CAA AERONAUTICAL CENTER
AIR NAVIGATION FACILITIES BRANCH
COMMUNICATIONS EQUIPMENT UNIT

UHF MILITARY EQUIPMENT LABORATORY EXPERIMENT

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Date March

R-361 RECEIVER

PURPOSE OF EXPERIMENT

The purpose of this experiment is to familiarize the student with the physical and electrical characteristics of the R-361 receiver. Approved methods of alignment and making performance measurements are used herein and the use of specialized test equipment and tools is required.

REFERENCES

Handbooks, Operating Instructions (TO #AN-16-30GRR7-1), Service Instructions (TO #AN-16-30GRR7-2), Overhaul Instructions (TO #AN-16-35R361-3), for Radio Set AN/GRR-7 (R-361/GR Receiver).

UHF Military Equipment Course Material.

Lecture Notes.

EQUIPMENT REQUIRED

Radio Receiver, Type R-361/GR.

HF Signal Generator, Measurements Corporation Model 65B.

UHF Signal Generator, Hewlett-Packard Model 608D.

Output Meter, General Radio Type 583A.

Vacuum Tube Voltmeter.

Frequency Meter, Model BC-221.

Miscellaneous Hand Tools, in Tool Box.

Assorted Cables and Test Leads.

Special Tools for R-361 Receiver.

PROCEDURE I (Familiarization)

A. Remove the receiver from the rack, taking out the bottom screws last, and place on its handles, face down, on the work table. Remove cover by loosening the four fasteners at rear and sliding up.

B. Locate R-F Subassembly and observe design and construction thereof.

1. Remove bottom cover of R-F subassembly at rear of chassis. Using the schematic drawing (use the blue Ozalid copy in back of binder instead of those in the books), look over the construction of the unit. Locate the following on both the schematic and the receiver:

a. J-401
b. C-432
c. U-401
d. C-402, R-401
e. V-401, Type? 6J4WA
f. L-404, C-404
g. C-403, R-403
h. C-401
i. L-401, C-407
j. C-406, R-404
k. V-404, Type? 6AK5W
l. C-425 and connection to T-301.
m. Observe compartmentation and shielding between input and output circuits of each tube.

C. Locate Oscillator Subassembly and observe design and construction thereof.

1. Remove bottom of oscillator subassembly next to R-F unit. Locate, both on the schematic, and on the receiver:

   a. A-501 (on top)
   b. L-505
   c. V-501, Type? 12AT7WA
   d. C-501, L-501
   e. C-502, L-502
   f. J-501, Name? 1st tripler Meter
   g. J-502, Name? 1st ampl. Meter
   h. J-503, Name? 2nd tripler
   i. J-504, Name? 2nd ampl. Meter
   j. U-501
   k. U-502 and the strap over to C-427 in the R-F subassembly.
   l. Y-502 (on top), Freq? 34.4 mc.
   m. V-505, Type? 12AT7
   n. E-501, Combination of coil and resistor
   o. C-528, C-534, L-504
   p. L-507 and wire to Second Mixer, V-301.

2. Replace the covers of both subassemblies, noting:

   a. Orientation of covers so that grounding strips align with compartmentation.

   b. Strap between covers.

D. Locate I-F strip and observe design and construction thereof.

1. Look over the general construction of the first and second I-F sections.

2. Read note on schematic above T-304.

3. Record the serial number of this receiver.

   Serial No. 3746

4. Locate the following test points:

   a. Center tab of C-351.

   b. Pins No. 1 of V-301, V-302, V-303 and V-304.

   c. Junction of R-325 and S-303, Noise Limiter Switch. (Important test point)

5. Locate the R-F GAIN control R-309. What tubes does it control? Gain of 1st + 2nd i-f.

E. Locate Audio, AVC and Power Sections, and observe design and construction thereof.

1. Locate, on the schematic, and on the receiver:

a. Tubes V-305 through V-312.

b. A-F GAIN control R-327.

c. AUDIO QUIETING DB control, R-333.

d. SQUELCH switch S-302.

e. Audio output transformer T-308 (not identified in Fig. 7-16, but is transformer immediately to the right of V-309).

f. AUDIO OUTPUT jack J-301. Output should be at least 1 watts into 600 ohms.

g. MUTING terminals. NOTE: The full output power (see above) is available at these terminals for a 600 ohm load.

h. MONITOR terminals. NOTE: Correct Service Instructions Handbook, Page 45, Paragraph 4-52, in part, to read . . . . . R-348 supplies + 15 dbm (15 db above one milliwatt) . . . . . Correction is underlined.

i. J-303 AVC METER jack.

j. Junction of R-342, R-343, C-331 (important test point - shorts out AVC when grounded).

k. POWER switch S-301 and r-f filters for the AC line L-313, C-345, etc.

PROCEDURE II (Alignment)

A. Connect A-C power to receiver, VTVM, BC-221 Frequency Meter, and HF Signal Generator.

B. Adjust Output Meter for 600 ohm load, with meter switch on highest output level setting. Connect AUDIO OUTPUT (phones) jack of receiver to Output Meter.

C. Set receiver R-F and A-F GAIN controls to extreme counter-clockwise position (minimum).

D. Turn receiver POWER switch to ON.

E. Allow equipment to warm up 10 minutes before attempting to align.

F. Align the 6 mc I-F Section.

1. Set receiver controls as follows:

   a. Turn the POWER switch to OFF.

   b. Turn the R-F GAIN control to extreme clockwise position. (Pointer should indicate "10")

   c. Turn the AUDIO QUIETING DB control to extreme counterclockwise position.

   d. A-F GAIN control is in extreme counterclockwise position.

   e. Turn the SQUELCH switch to OFF position.

   f. Turn the NOISE LIMITER SWITCH, located on the main chassis, to the OFF position.

2. Short the AVC bus to ground, by means of a jumper from the junction of R-342 and R-343 to the chassis.

3. Set the vacuum tube voltmeter to "-3V D-C" scale, and connect connect D-C lead to the junction of R-325 and S-303. Connect common lead to receiver chassis.

4. Connect one side of a .05 mfd paper capacitor in series with the center conductor lead from the signal generator. Connect the other side of the capacitor to the center tab of C-351, by means of a clip lead.

5. Connect the ground lead from the signal generator to the receiver chassis, by means of a short length of bus wire (three inches or less).

NOTE: When connecting the signal generator to the receiver, the length of the connecting leads must be kept to a minimum.

6. Make certain the MODULATION control on the signal generator is set to OFF.

7. Set the frequency meter to 6 mc, and connect it to the center conductor lead from the signal generator.

8. Set the output of the signal generator to 500,000 uv, and carefully turn frequency dial of the signal generator until zero beat is heard in the earphones, plugged into the frequency meter.

9. Disconnect the frequency meter from the circuit. The signal generator is now set to 6 mc.

NOTE: Do not turn the frequency control knob on the signal generator once the alignment has been started.

10. Turn the POWER switch on the receiver to ON.

11. Adjust the output of the signal generator until the vacuum tube voltmeter swings to a level of about -1.0 volt.

12. Refer to Figure 1-4, R-361 Service Instructions Handbook for location of primary and secondary connections.

13. Carefully clip a 680 ohm aligning resistor across the primary of I-F transformer T-303.

14. Increase the output of the signal generator until the VTVM again reads approximately -1.0 volt.

15. Slowly tune the secondary (top slug) of T-303, until a maximum reading is obtained on the VTVM.

NOTE: Reduce signal generator output as required to prevent pinning VTVM meter needle and to maintain approximately a -1.0 volt output indication.

16. Remove the 680 ohm resistor from the primary of T-303, and apply it to the secondary.

17. Slowly tune the primary (bottom slug) of T-303, until the VTVM indicates maximum.

18. Repeat steps 13 through 17 on I-F transformers T-304, T-305 and T-306.

19. Remove the 680 ohm aligning resistor.

20. Remove the AVC grounding connection from the junction of resistors R-342 and R-343 to ground.

21. Transfer the D-C lead of the VTVM from the junction of R-325 and S-303, to AVC METER jack J-303.

22. Increase the output of the signal generator until the VTVM reads approximately -1.0 volt.

23. Tune the bottom slug of T-302 until a maximum output is obtained.

G. Determine gain of 6 mc I-F Section as follows:

1. Short AVC to ground with a jumper from the junction of R-342, R-343 and C-331.

2. Measure gain of third 6 mc I-F stage.

a. Adjust receiver controls as follows:

(1) POWER switch to ON.

(2) SQUELCH switch to OFF.

(3) NOISE LIMITER switch to OFF.

(4) R-F GAIN full counterclockwise.

(5) A-F GAIN full counterclockwise.

(6) AUDIO QUIETING DB full counterclockwise.

b. Connect VTVM between test point H and ground.

NOTE: See receiver schematic for location of test points.

c. Connect HF Signal Generator between test point I and ground using a .05 mfd capacitor in series with the "hot" lead of the generator.

10,000

d. Set output frequency of signal generator to 6 mc (as determined by BC-221 previously), with MODULATION to OFF.

e. Adjust output level of signal generator to produce exactly -1.0 volt D-C on the VTVM. Record this value on the attached performance data sheet. Value should be less than 150,000 uv. 10,000

3. Measure gain of second 6 mc I-F stage.

a. Adjust receiver controls same as in step 2-a except:

(1) R-F GAIN control full clockwise.

b. Connect HF Signal Generator to test point J.

c. Adjust output level of signal generator to produce exactly -1.0 volt D-C on VTVM. Record this value on the attached performance data sheet. Value should be less than 15,000 uv. 2, K

4. Measure gain of first 6 mc I-F stage.

a. Adjust receiver controls same as in step 3, a.

b. Connect HF Signal Generator to test point K.

c. Adjust output level of signal generator to produce exactly -1.0 volt D-C on VTVM. Record this value on the attached performance data sheet. Value should be less than 500 uv. 15-0 uv

5. Measure overall gain of 6 mc I-F Section.

a. Adjust receiver controls same as in step 3, a.

b. Connect HF Signal Generator to test point L.

c. Adjust output level of signal generator to produce exactly -1.0 volt D-C on VTVM. Record this value on the attached performance data sheet. Signal generator output level required should be between 390 and 810 uv. 320 280 uv

H. Determine the center frequency of the 6 mc I-F section as follows:

1. Set receiver controls and special conditions as indicated in Steps G-1 and G-5 above.

2. Connect test equipment to receiver as indicated in Step G-5 above. (VTVM connected between Test Point H and ground).

3. Adjust output frequency of HF Signal Generator to approximately 6 mc and then refine frequency adjustment to give a maximum reading on VTVM. Adjust output level of signal generator to approximately -1.0 volt on VTVM.

4. Vary frequency of signal generator above and below 6 mc and notice that a peak is obtained in both instances. Now vary the frequency from one peak to the other, and note the frequency between the two peaks, at which minimum output from the i-f strip is obtained.

5. Connect the frequency meter to the output of the signal generator. Increase the output of the signal generator until sufficient signal is available, at the frequency meter, to detect a beat-note. The frequency meter dial setting corresponds to the center frequency of the I-F Amplifier and should be 6 mc $\pm$ 1 kc.

NOTE: The specification "6 mc + 1 kc" is given for the condition where the 680 ohm aligning resistor is a 1/4 watt unit and is soldered into the circuit as required during the 6 mc I-F section alignment. As 1/2 watt, 680 ohm resistors (larger size-greater capacity to ground) are connected into the circuits by alligator clips (more capacity) in the foregoing experiment, it is to be expected that the center frequency of the I-F section will be out of the tolerances specified. However, record the actual measured frequency on the attached performance data sheet.

I. Measure the 6 mc I-F bandwidth as follows:

1. Set receiver controls and special conditions as indicated in Step G-1 and G-5 above.

2. Connect test equipment to the receiver as indicated in Step G-5 above. (VTVM connected to Test Point H and ground).

3. Set signal generator to same frequency as determined in Step H above.

4. Set output level of signal generator to 500 uv.

5. MODULATION control on generator should be OFF.

6. Read and record VTVM indication.

7. Increase output of signal generator to 1000 uv.

8. Detune the signal generator above and below center frequency until VTVM reading is same as in Step 6. Note and record these two frequencies. (Use "Dial" scale of 65B Signal Generator to improve accuracy of these readings).

9. The difference between the two readings in Step 8 is the 6 db bandwidth of the receiver. It should be more than 60 kc for the receivers used in this laboratory.

10. Increase output of signal generator to 500,000 uv.

11. Detune signal generator above and below center frequency until VTVM reading is same as in Step 6. Note and record these two frequencies. (Use "Dial" scale of 65B Signal Generator to improve accuracy of these readings).

12. The difference between the two readings obtained in Step 11 is the 60 db bandwidth. It should be less than 175 kc for the receivers used in this laboratory.

13. Record the 6 db and 60 db bandwidths on the attached performance data sheet.

14. Remove jumper shorting AVC to ground.

J. Align the Second Oscillator.

1. Connect the D-C probe of the VTVM (with built-in 1-megohm isolating resistor) to Pin 1 of V-301.

2. Tune the 2ND OSC TUNING control for maximum indication on the VTVM.

3. Detune 2ND OSC TUNING slightly on the stable side of resonance. (On the unstable side of resonance, the oscillator will drop sharply out of oscillation). Check with the instructor in case of difficulty.

K. Align the First Oscillator.

1. Determine receiver channel frequency as follows:

a. Note frequency of crystal Y-501 in first oscillator.

b. Multiply crystal frequency by nine (9) and add 40.4 mcs to the product. The result will be the receiver channel frequency. 379.40003

2. Set all the tuning dials to approximately the correct frequency as determined in Step K-1 above. See Figure 1-3 of Service Instructions #AN16-30GRR7-2 for location of dials if necessary.

3. Connect VTVM to the 1st TRIPLE METER jack J-501 and tune the 1st OSC adjustment for a peak on the VTVM.

4. Connect VTVM to the 1st AMPL METER jack J-502 tune the 1st TRIPLE PLATE adjustment for a peak on the VTVM.

5. Connect VTVM to the 2nd TRIPLE METER jack J-503 and tune the 1st AMPL plate adjustment for a peak on the VTVM.

6. Connect VTVM to the 2nd AMPL METER jack J-504 and tune the 2nd TRIPLE PLATE adjustment for a peak on the VTVM.

7. Set the 2nd AMPL PLATE adjustment to the desired frequency on the scale.

L. Align the R-F Section.

1. Connect a VTVM to the junction of R-325 and S-303.

2. Connect the UHF Signal Generator to the ANT INPUT jack.

3. Adjust output level of the signal generator to get a nominal output on the VTVM. MODULATION control on signal generator should be on EXT MOD.

4. "Rock" the signal generator frequency dial for a maximum indication on the VTVM. (About half-scale on "3" V. D-C range)

5. Adjust the ANT, 1st R-F PALTE, 2nd R-F Plate, and 3rd R-F PLATE tuning adjustments to the approximate desired frequency. See Step K-2 above.

6. Make a final adjustment on the above four controls as well as the others indicated, by noting a peak on the VTVM, in the order given below: (Not more than half-scale on "3" V. D-C range)

   a. 2nd AMPL PLATE
   b. ANT
   c. 1st R-F PLATE
   d. 2nd R-F PLATE
   e. 3rd R-F PLATE
   f. T-301 (top slug)
   g. T-301 (bottom slug)
   h. L-307 (bottom slug)
   i. Repeat steps 6-a through 6-h.

PROCEDURE III (Performance Measurements)

A. R-F Sensitivity.

1. Set receiver controls as follows:

   a. POWER switch to ON.
   b. R-F GAIN full clockwise.
   c. A-F GAIN full clockwise.
   d. SQUELCH switch ON.
   e. NOISE LIMITER switch ON.
   f. AUDIO QUIETING DB control full counterclockwise.

2. Connect output meter to receiver AUDIO OUTPUT (phones) jack. Set output meter impedance to 600 ohms and level multiplier to 100.

3. Connect UHF Signal Generator to antenna input of receiver.

4. Turn signal generator POWER to OFF.

5. Note whether or not an output level (noise) is indicated on the output meter. (Decrease level multiplier if necessary) 30 m watt

   a. If an output is indicated (noise), reduce the R-F GAIN control until this noise is squelched.

   b. If no output is indicated (noise), proceed with the next step, leaving the R-F GAIN control full clockwise. Record setting of R-F GAIN control. 9.5 dd

6. Turn signal generator POWER to ON.

7. Turn SQUELCH to OFF.

8. Set output level of signal generator to 3.0 uv, modulated 30% with 1000 cps, on channel frequency.

9. Set A-F GAIN of receiver so that output level is 10 mw.

10. Turn MODULATION control on signal generator to EXT MOD.

11. The output level as noted on the output meter should drop at least 10 db.

    a. If it drops more than 10 db, repeat 8, 9, and 10, using a smaller signal input until a signal to noise ratio of 10 db is obtained.

    b. If it fails to drop 10 db, sensitivity is below normal. Check equipment and test equipment settings and connections, and if trouble cannot be remedied, contact an Instructor.

12. Record R-F sensitivity on the attached performance data sheet.

NOTE: This receiver is designed to provide 10 mw of audio power across a 600 ohm balanced load, with an input signal not greater than 3 uv, modulated 30% at a frequency of 1,000 cps. These conditions must be met when maintaining a minimum signal plus noise, to noise ratio of ten to one.

B. Measure voltage levels in First and Second Oscillator sub-assemblies as follows:

1. First Oscillator, V-501.

   a. Connect D-C probe of VTVM between 1st TRIPL METER jack J-501 and ground.

   b. Measure output of first oscillator V-501. Level indicated on VTVM should be approximately -1.0 volt.

2. First tripler V-501.

   a. Connect VTVM between 1st AMPL METER jack J-502 and ground, using D-C probe of VTVM.

   b. Measure first tripler output. Level indicated on VTVM should be approximately -1.5 v.

3. First Amplifier, V-502.

   a. Connect VTVM between 2nd TRIPL METER jack J-503 and ground, using D-C probe of VTVM.

   b. Measure 1st amplifier output. Level indicated on VTVM should be approximately -3 volts.

4. Second Tripler, V-503.

   a. Connect VTVM between 2nd AMPL METER jack J-504 and ground, using D-C probe of VTVM.

   b. Measure second tripler output. Level indicated on VTVM should be approximately -1.0 volt.

5. Second Oscillator, V-505.

   a. Touch D-C probe of VTVM to pin 1 of V-301. Connect negative lead of VTVM to ground.

   b. Measure second oscillator output. Level indicated on VTVM should be approximately -4 to -10 volts.

C. Check image rejection ratio as follows:

1. Set receiver controls as indicated in Step A, R-F Sensitivity.

2. Connect test equipment as indicated under R-F Sensitivity.

3. Adjust R-F GAIN control of receiver to setting determined in Step A-5, R-F Sensitivity.

379.4
80.8
298.6

4. Turn SQUELCH switch to OFF.

5. Tune signal generator to image frequency. (Channel frequency minus twice the 1st I-F frequency)

6. Set output of signal generator to 350,000 uv, 30% modulated at 1000 cps, and refine frequency adjustment to give maximum output as indicated on output meter.

3.5dd

7. Adjust receiver A-F GAIN control to give an output level of 10 mw.

8. Retune signal generator to channel frequency.

9. Adjust signal generator output level to about 5 uv, 30% modulated at 1000 cps, and tune signal generator for maximum indication on the output meter.

10. Readjust output of signal generator to develop the same output as in Step 7 above (10 mw). Image rejection should be at least 80 db. Record value obtained on attached performance data sheet.

93.0

D. AVC Characteristics

1. The design specification for this equipment limits the maximum total change of output to 4 db for an input range of 10 to 100,000 uv. With an input of one volt, the audio output level is not to vary more than 6 db above one watt. To check the AVC characteristics, proceed as follows:

NOTE: An output level of one volt is not obtainable on the signal generators used in this laboratory. Therefore, measurements requiring use of a one volt input to the receiver will not be made.

a. Adjust the R-F GAIN control as explained under "R-F Sensitivity".

b. Set the A-F GAIN control to produce one watt output with 50 uv input, which is the 0 db reference level used during the AVC measurement.

c. Vary the output of the signal generator to 10, 1,000, 10,000 and 100,000 uv, while maintaining 30% modulation at 1,000 cycles per second. The output variation should be less than 4 db for signals up to the 100,000 uv level. Record results on the attached performance data sheet.

E. Audio Power Output

1. The audio power output for this receiver, should be at least one watt across 600 ohms with an R-F input signal of 50 uv modulated 30 percent at an audio rate of 400 to 3,000 cps. In order to check this requirement, proceed as follows:

a. Set the A-F GAIN control to the extreme clockwise position.

b. Set the output of the signal generator to 50 uv, 30 percent modulated with 400 cps and then 1,000 cps (both internal).

c. The power output should indicate at least one watt for both of these frequencies. Record results on the attached performance data sheet.

F. Squelch Check

1. Set receiver controls as indicated in Step A-1, "R-F Sensitivity".

2. Connect test equipment as indicated under Step A-2, 3, "R-F Sensitivity".

3. Set R-F GAIN control to setting determined in Step A-5, "R-F Sensitivity".

4. Turn SQUELCH switch to OFF.

5. Set signal generator output to 3 uv, modulated 30% with 1000 cps on channel frequency.

6. Refine signal generator frequency adjustment for maximum indication on the output meter.

7. Turn SQUELCH switch to ON. (AUDIO QUIETING DB control should be maximum counterclockwise).

8. Reduce signal generator output to minimum. Output level should be extremely low or zero on output meter.

9. Slowly increase signal generator output level until the squelch opens and an output is noted on the output meter. Record this level (squelch threshold) on the attached performance data sheet.

G. Check receiver for any missing parts, nuts screws, etc. Replace as required. Replace dust cover and reinstall receiver in rack.

REVIEW QUESTIONS

A. Complete the applicable review questions and submit to instructor on the day following completion of the experiment.

Name Charles G. Turner

R-361 Serial Number 3746 Date March

6 mc I-F Measurements

70,000 uv at Point I to produce - 1.0 volt DC at Point H.
2,000 uv at Point J to produce - 1.0 volt DC at Point H.
150 uv uv at Point K to produce - 1.0 volt DC at Point H.
320 uv uv at Point L to produce - 1.0 volt DC at Point H.

6 mc I-F Center Frequency .0015 mc.

6 mc I-F Bandwidth 1000 uv (6 db) 68 kc.
500,000 uv (60 db) 159 kc.

Noise level squelched at R-F GAIN control setting of 9.5 dd.

R-F SENSITIVITY: 3 uv for 10 db S/N ratio.

CHANNEL FREQUENCY: 379.1 mc.

OSCILLATOR TUNING

1-st Oscillator:

Voltage at J-501 — 1.5 v. DC Voltage at J-503 -3 v. DC
Voltage at J-502 — 1.7 v. DC Voltage at J-504 -2 v. DC

2nd Oscillator Voltage at Pin 1, V-301 -7 v. DC

IMAGE REJECTION: Image Feequency 298.6
Image Rejection Ratio 93.0 db.

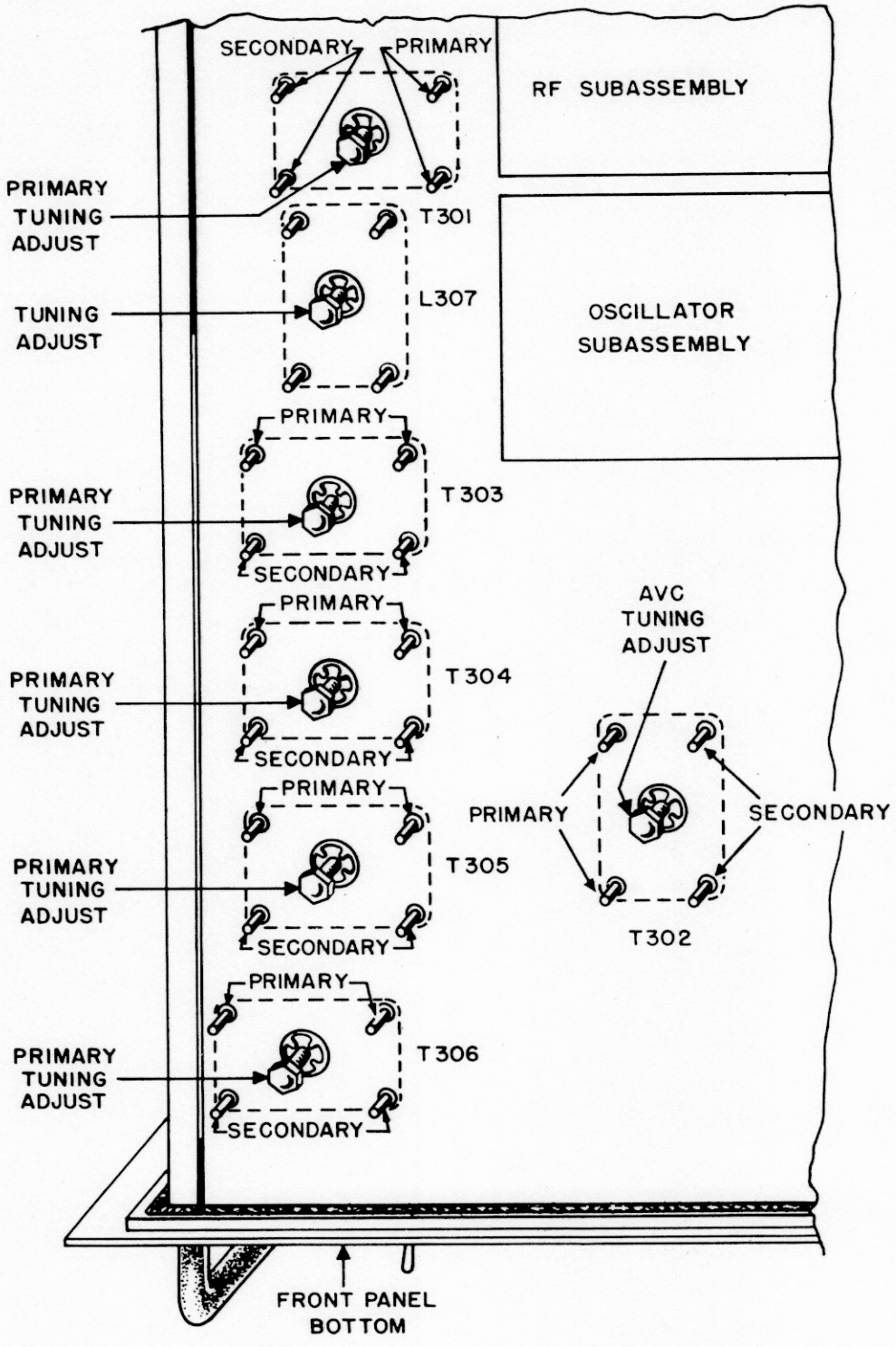
AVC CHARACTERISTIC

3 db change in output from 10 to 100,000 uv input.

AUDIO POWER OUTPUT

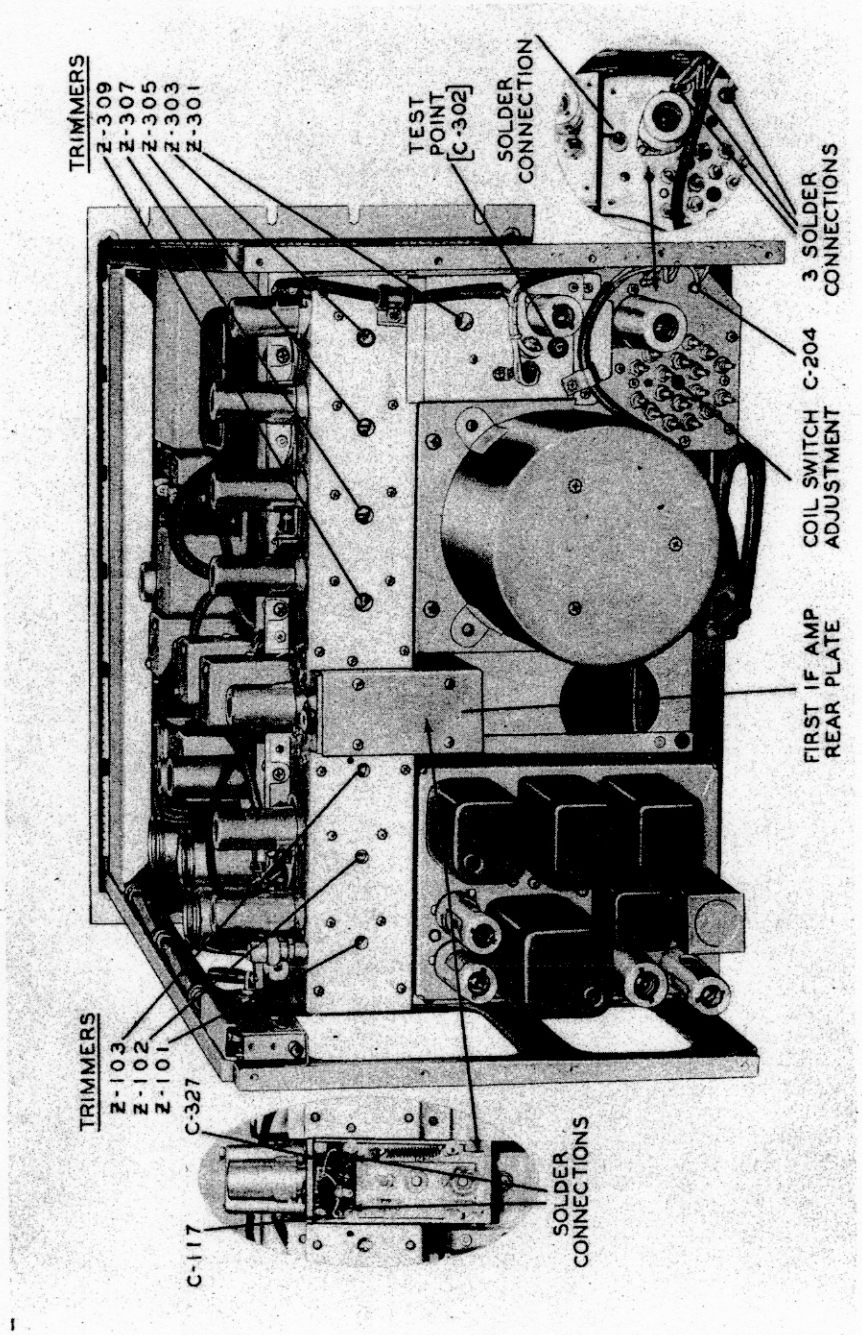
50 uv input, 400 cycles 300 w.
1000 cycles 600 w.

SQUELCH THRESHOLD .125 uv.

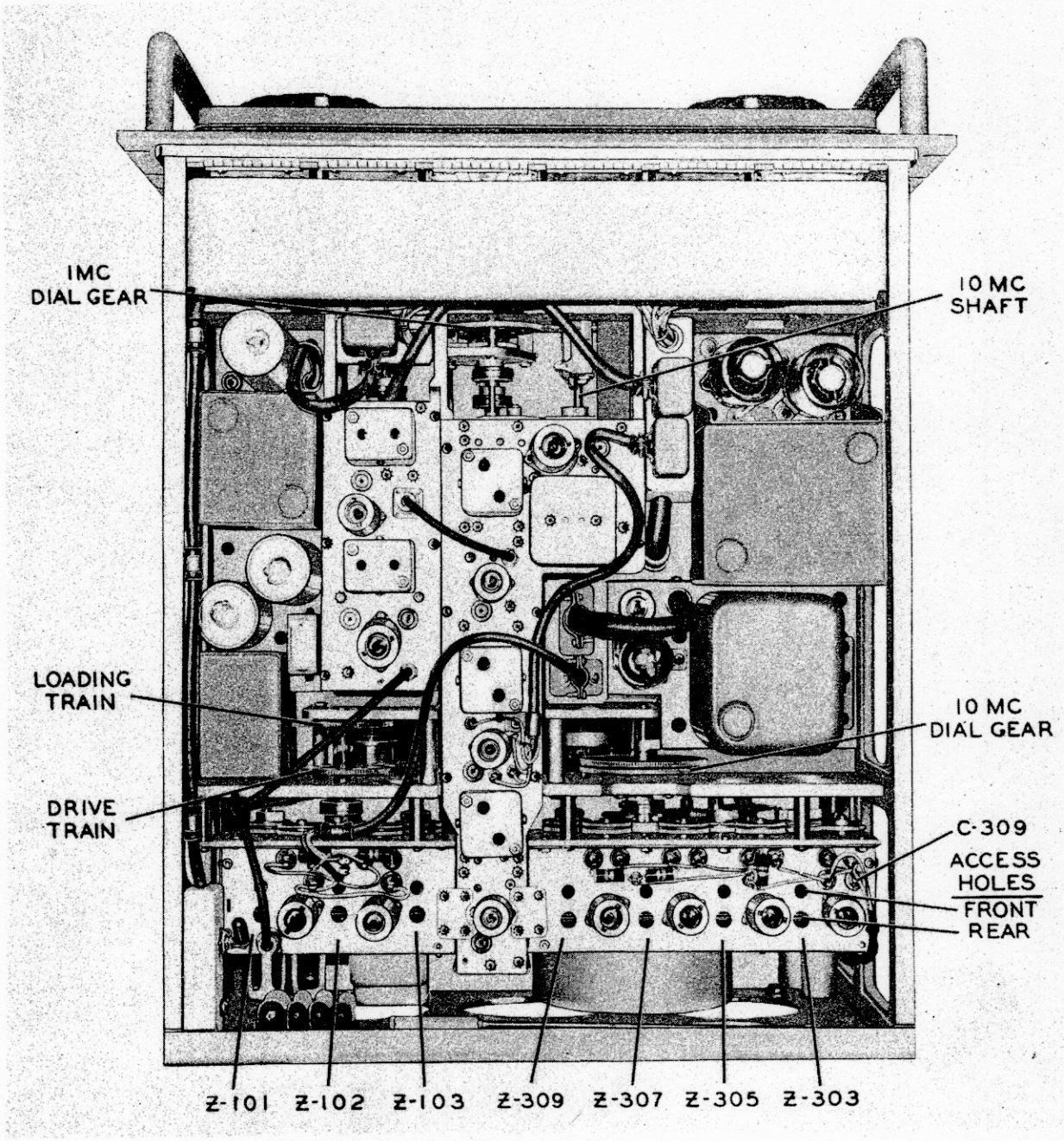


Radio Receiver R-361/GR, Bottom View, Dust Cover Removed

Rev. 1/59

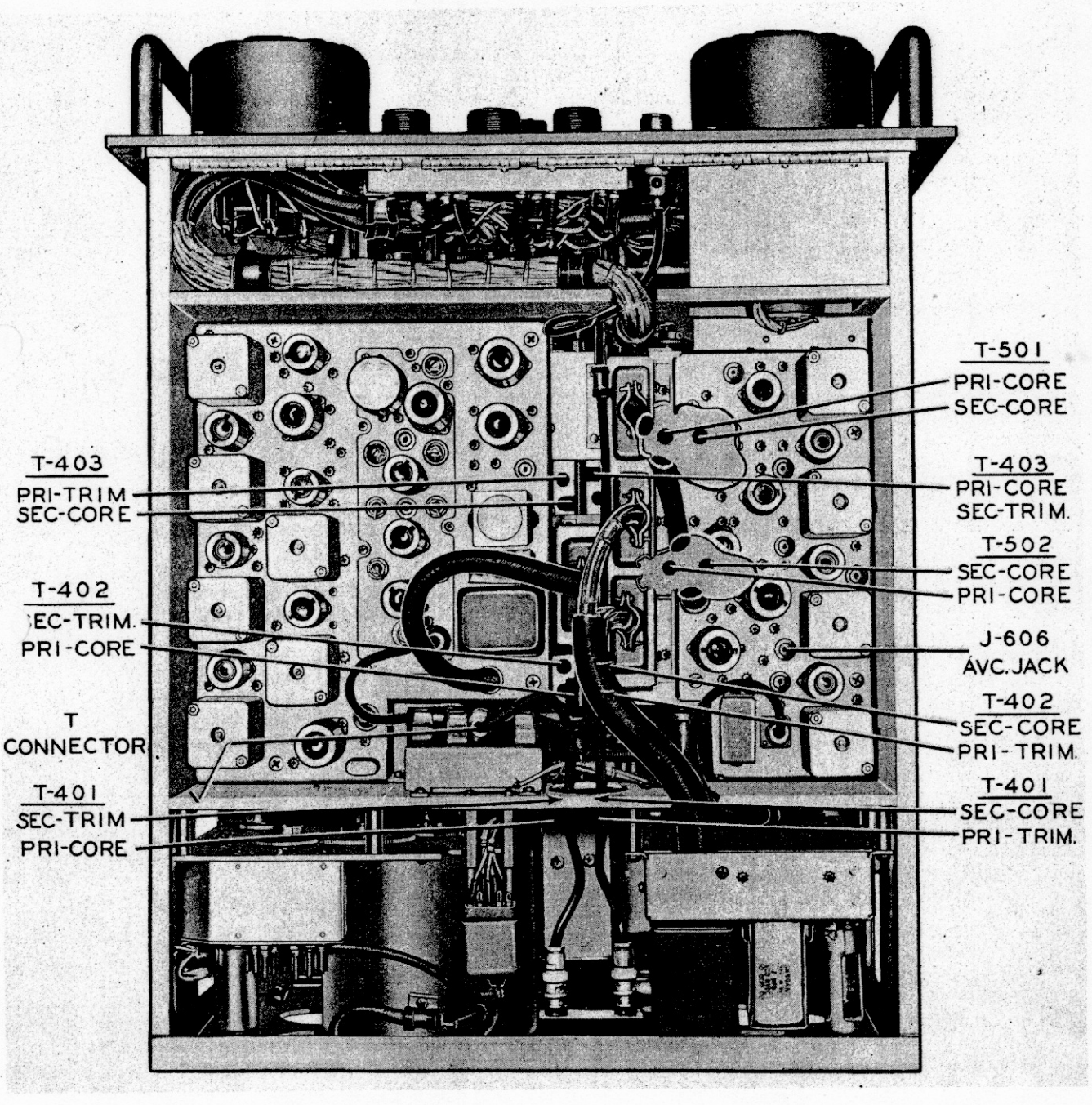


Radio Receiver R-278/GR, Rear View



Radio Receiver R-278/GR Alignment Points, Top View

Rev. 1/59



Radio Receiver R-278/GR Alignment Points, Bottom View

CAA AERONAUTICAL CENTER
AIR NAVIGATION FACILITIES BRANCH
COMMUNICATIONS EQUIPMENT UNIT

UHF MILITARY EQUIPMENT LABORATORY EXPERIMENT

Name Charles G. Turner

Date 3/2/59

T-282 TRANSMITTER AND MD-141A MODULATOR-POWER SUPPLY

PURPOSE OF EXPERIMENT

The purpose of this experiment is to familiarize the student with the physical and electrical characteristics of the T-282 Transmitter and MD-141A Modulator-Power Supply. Approved methods of transmitter tune-up are employed and the student is required to adjust and measure the modulation percentage of this equipment.

REFERENCES

Handbook Service Instructions, Radio Transmitting Set AN/GRT-3, AN #16-30GRT3-2.

Handbook Operating Instructions, AN #16-30GRT3-1.

UHF Military Equipment Course Material.

Lecture Notes.

EQUIPMENT REQUIRED

T-282/GR Transmitter

MD-141A/GR Modulator-Power Supply

RF Load, 52 ohm Termaline

Multimeter

Audio Oscillator

Audio Attenuator

PROCEDURE I (Familiarization)

CAUTION: Extreme care must be used in handling Transmitter and Modulator-Power supply units to avoid personal injury and major damage to equipment. Always use two men to handle these units and coordinate your movements since they are quite heavy. Keep hands and feet clear to avoid serious personal injury in case of mishap. Observe usual precautions to avoid electrical shock.

A. Transmitter Familiarization

1. Disconnect A-C Power Input cable from Modulator-Power Supply.
2. Remove all cable connectors from rear of T-282 Transmitter.
3. Move transmitter to work table and remove dust cover.
4. Loosen all dial locks.
5. Loosen and pull forward "Monitor-Screen Modulator" Unit for inspection.
6. Remove the air filters and the perforated plates beneath them. (Be careful not to lose the mounting screws.)
7. Note location of all tubes.
8. Locate the three interlock switches associated with access panels.
9. Observe location and markings on the one switch and six potentiometers on the "Monitor-Screen Modulator Unit".
10. Put the Monitor-Screen Modulator unit back in place.
11. Make sure all dial locks are loose.
12. Rotate MAIN TUNING (crank) dial to one end of its range, then back to the other end.

    a. Note effect on other dials.
    b. Which dials are effected by MAIN TUNING?

PA Grid – PA Plate – 2nd doubler Plate
Osc & 1st dblr Plate Driver Plate DRIVER Grid

13. Rotate dials individually and observe (where possible) which components are varied and how much?

14. Locate on right side of unit, the following:

    a. Splien Wrenches

    b. Interlock Switch S-901

15. Locate on bottom of Unit:

    a. Low Pass Filter

    b. Micro-Match Directional Coupler

    c. Terminal Boards E-901, E-902 and E-903

    d. Push-to-Talk Relay

16. Examine on front of Transmitter.

    a. Test Points

    b. Crystal Holder

17. Inspect fuses for correct type and rating.

18. Trace the path of air flow from front filter through blower to rear filter.

    a. Which tubes are not cooled by the blower?

19. Replace Perforated Covers, Air Filters and Dust Cover.

20. Return transmitter to rack and re-connect cables to transmitter only.

B. Modulator-Power Supply Familiarization

1. Remove Modulator-Power supply from rack and place on small work table.

2. Remove rear Air Filter.

3. Locate and examine the following: (A flashlight will help).

    a. Outlet air filter interlock and its "cheater".

    b. Location of 6AL5W tube socket

c. Fuses (Check for proper ratings)

d. Buck-Boost Switch

e. Line, Control and Ground terminal block

f. Cable and Power connectors

4. Carefully remove front air filter and fan motor as a unit. (Loosen four thumb screws and pull straight out on handles).

5. Observe that a small silver plated vane protrudes into the opening.

a. This is an air controlled switch

b. Do not bend or distort it

6. Note location of tubes and components visible within unit.

7. Locate and identify:

a. Power Switch

b. Plate Switch

c. Limiter Threshold Control

d. Audio Gain Control

e. Push-to-Talk, Carrier-On Switch

f. Emergency-Normal Switch

g. Narrow-Broad Switch

h. Blower Fan Connector Plug

i. Test Points

j. Indicator Lamps

k. Interlock Switch

8. Replace fan and air filters.

a. Use caution to replace in proper position

9. Replace dust cover and reinstall in rack.

C. Distribution Panel J-390/GR Familiarization

1. Note A-C power busses and terminal strips.

2. Note plastic safety cover with holes for measuring A-C voltages.

PROCEDURE II (Adjustments)

A. Reconnect all interunit cables and A-C power cable to equipment and turn POWER ON-OFF switch to ON.

B. Terminate transmitter output in R-F dummy load.

C. Tune Transmitter:

1. Crystal frequency is marked on oven cover. Determine output frequency by multiplying crystal frequency by 36.

2. Turn the TUNE-OPERATE switch to the TUNE position.

3. Place CARRIER ON -PUSH TO TALK switch in CARRIER ON position.

4. Set METER 1 SELECTOR SWITCH to "1" METER 2 SELECTOR SWITCH to CARRIER WATTS.

5. With all tuning dial locks loose, (from above) set MAIN TUNING dial to desired frequency and tighten the dial lock.

6. Turn the OUTPUT COUPLING control to its extreme counterclockwise position.

7. Turn the PLATE ON-OFF switch to the ON position. The red indicator above the switch will light. A reading of approximately .04 milliampere should be observed on METER 1.

8. Set METER 1 SELECTOR SWITCH to position "2" and tune OSC & 1ST DOUBLER PLATES control until METER 1 reads maximum. Lock control, exercising caution that its setting is not disturbed. This caution should be exercised when locking other tuning controls, as required in the following steps.

#1

#3

9. Set METER 1 SELECTOR SWITCH to position"3" and tune the 2ND DOUBLER PLATE control until METER 1 reads maximum. Lock control.

#4

10. Set METER 1 SELECTOR SWITCH to position "4" and tune the BUFFER AMPLR PLATE control until METER 1 reads minimum.

#5

11. Set METER 1 SELECTOR SWITCH to position"5" and tune the DRIVER GRID control until METER 1 reads maximum.

12. Readjust the BUFFER AMPLR PLATE and DRIVER GRID controls to obtain a maximum reading on METER 1. Several successive adjustments of these two controls will be necessary before a true maximum reading can be obtained. Lock both controls.

13. Set METER 1 SELECTOR SWITCH to position "7" and tune the DRIVER PLATE control until METER 1 reads minimum. If a minimum reading can not be observed, proceed with the next step.

14. Set METER 1 SELECTOR SWITCH to position "6" and tune the PA GRID control to obtain the maximum reading on METER 1.

15. With METER 1 SELECTOR SWITCH still on position "6", manipulate the PA GRID and DRIVER PLATE controls until METER 1 reads maximum. If resultant reading on meter is greater than 0.4 detune DRIVER GRID control until meter reads 0.4. Lock both controls.

16. Tune the PA PLATE control until METER 2 reads maximum.

17. Set METER 1 SELECTOR SWITCH to position "8", throw the TUNE-OPERATE switch to the OPERATE position and tune the PA PLATE control until METER 2 reads maximum.

18. Generally, it is desirable to leave the OUTPUT COUPLING control at the extreme counterclockwise position (step 6). If 100 watts output cannot be achieved by tuning of the PA PLATE control alone, manipulate the PA PLATE and OUTPUT COUPLING controls until at least 100 watts output is achieved. (Between 90 and 100 watts is acceptable for the school equipment) Normal indication on METER 1 is 0.50 to 0.62 milliamperes.

19. Recheck above tuning. Note that plate circuits (except the P.A.) are tuned for maximum grid drive. All grids (except the Driver Grid) are tuned for maximum grid current.

NOTE: Also see table 6-1, Minimum Performance Standards, Field, Handbook Service Instructions, AN16-30GRT3-2 as required.

D. Modulation Adjustments

1. The T-282 Transmitter was not originally designed for use with CAA transmitter control equipment. The carbon microphone is not commonly used in CAA stations and the methods described in Paragraphs 2-10 and 2-12 of AN16-30GRT-1 are likewise not suitable for CAA use. Regional modifications have been made to separate the audio and control circuit inputs, but to our knowledge no standard has been adopted. We shall use a 600 ohm "normal" audio line input and utilize the CARRIER-ON position of the PUSH-TO-TALK - CARRIER ON switch for control.

2. Reduce the GAIN control setting on the MD-141A to zero.

3. Turn the LIMITER THRESHOLD adjustment as far counterclockwise as it will go.

4. Connect apparatus as follows:

   a. Audio oscillator output to CA-403 Attenuator input. Multimeter is connected across audio oscillator output.

   b. CA-403 Attenuator output is connected to 600 ohm input terminals, AUDIO LINE INPUT, at lower left rear side of modulator MD-141A.

5. Adjust audio oscillator and attenuator for zero db (6 mw) at 1000 cycles, into a 600 ohm line.

6. Calibrate METER 2 as follows:

   a. Turn METER 2 SELECTOR SWITCH to SET CAL.

   b. Key transmitter (CARRIER ON).

   c. Turn CALIBRATE control, next to METER 2 SELECTOR SWITCH until pointer of METER 2 indicates CAL at right end, bottom scale.

7. With METER 2 SELECTOR SWITCH on % MOD, advance the MD-141A GAIN control until METER 2 reads 95% modulation.

   a. Record the gain control setting, estimating tenths of dial divisions _____.

8. Calculate the percentage of modulation that is 1.5 db below 95%:

   $db = 20 \log \frac{95}{x}$ Answer 79.9 or 80%

9. Adjust LIMITER THRESHOLD control to reduce the percentage of modulation, as indicated on METER 2, to this figure.

10. Plug in a carbon microphone and advance gain control until normal voice modulation is evident as you speak into it.

    a. Note limiting action apparently keeps the modulation below about 75%.

    b. Monitor output by plugging headphones into SIDETONE OUTPUT jack on front panel of transmitter.

E. Recording of Data

1. Record all meter readings on the attached meter reading form.

2. Contact an Instructor for a final check of the transmitter adjustments.

REVIEW QUESTIONS

A. Complete applicable review questions and submit to instructor on the day following completion of the experiment.

T-282 TRANSMITTER AND MD-141A MODULATOR-POWER SUPPLY

RECORD OF METER READINGS AND ADJUSTMENTS

Name _____

Date _____

Transmitter Serial Number		
Crystal Frequency		
Output Frequency		
CIRCUIT	METER 1 Indication	Current
Oscillator Grid		
2nd Doubler Grid		
Buffer Grid		
Buffer Plate		
Driver Grid		
P. A. Grid		
Driver Plate		
P. A. Plate		
	METER 2	
Power Output, watts		

CAA AERONAUTICAL CENTER
AIR NAVIGATION FACILITIES BRANCH
COMMUNICATIONS EQUIPMENT UNIT

UHF MILITARY EQUIPMENT LABORATORY EXPERIMENT

Name Charlie Turner

Date _____

R-278B RECEIVER FAMILIARIZATION

PURPOSE OF EXPERIMENT

The purpose of this experiment is to familiarize the student with the physical and electrical characteristics of the R-278B receiver and associated components of the AN/GRC-27 Radio Set. The student will become acquainted with the operating adjustments of this equipment and will receive training in the removal and replacement of subassemblies and the mechanical synchronization checks necessary to insure proper operation.

REFERENCES

Handbook Operation and Service Instructions, Radio Set AN/GRC-27, To #16-30GRC27-1.

Handbook Maintenance Instructions, Receiver Group OA-192/GR, To #16-350A192-3.

Lecture Notes.

UHF Military Equipment Course Material.

EQUIPMENT REQUIRED

Radio Receiver, Type R-278B/GR.

Antenna, Type AT-197/GR.

Control Indicator, Type C-806/GR.

A-F Amplifier, Type AM-447/G.

Tools furnished with receiver.

Tool Box with assorted tools.

Special frequency selector extension cable.

PROCEDURE I (Familiarization)

A. Antenna, AT-197/GR.

1. Remove, examine, and re-install:

a. Simulated disc.

b. One or more rods of simulated cone.

2. Remove antenna cable from receiver and antenna and examine cable and connectors. Replace cable.

a. The coaxial cable prescribed for long runs is RG-17U. Ask Instructor to show sample of this cable if it is unfamiliar to you. Short jumpers of RG-8/U are used at either end, however, as they are more flexible.

B. Control Indicator, C-806/GR.

1. Remove rear cover and locate, both on the schematic inside the cover, and on the unit:

a. Receiver and transmitter channel selectors.

b. Headset Jack

2. The remainder of the circuitry provides an amplified sidetone from the transmitter for monitoring purposes. A-C power does not have to be supplied to the unit to control the receiver. Replace cover.

C. A-F Amplifiers, AM-447/G

1. Remove an AM-447/G Amplifier by lifting and sliding it out. Lay amplifier on bench. Using the schematic on under side of bottom plate of amplifier, locate both on the schematic, and on the unit:

a. Input and output connections; impedance

b. GAIN control

(1) Used in conjunction with VOLUME SPEAKER control to set the output level of the amplifier.

c. VOLUME SPEAKER control

(1) Sets the output level at which volume limiting begins. (See b, (1)

2. This amplifier is of the volume limiting type, similar to that of CAA line amplifiers. Locate on the schematic the following:

a. 6H6 limiter tube.

b. Its load resistor R-104 and time constant filter capacitor C-105.

c. Variable-mu controlled tube 6SK7.

3. Replace cover and amplifier.

D. Receiver, R-278B/GR

1. From the nameplate, record:

Type R-278B/GR Serial No. 934

Manufacturer Delco Remy Div. Gen. Mtrs. Div.

2. Remove receiver from rack and place on front handles on small work table.

3. Remove rear cover by loosening the four Dzus fasteners. Locate both on the schematic drawings on the cover and on the receiver itself, these sub-units:

a. Frequency selector

b. R-F low pass filter

c. R-F Amplifier

d. Main oscillator

e. Frequency multiplier-amplifier

f. First I-F amplifier

g. Second I-F amplifier. Note crystals just visible at rear of sub-unit.

h. Third I-F amplifier

i. Audio amplifier

j. Power supply rectifier

k. Power supply filter

l. Interlock switch. Note disabling feature

m. Power cable CX-1541/U

n. Local control cable CX-1540/U. Where it goes.

4. Locate on the front panel the operating controls described in the Operation and Service Instruction Book for the AN/GRC-27 Radio Set, Paragraph 4-10, Page 23.

5. In addition to physical location, trace the following controls on the schematic and note their function:

a. R-F GAIN control

(1) Adjusts squelch threshold level.

(2) Effective only in LOCAL position of R-F GAIN switch.

(3) Controls gain of R-F and I-F amplifiers.

b. A-F GAIN control

(1) Controls only the volume to the PHONES jack on the receiver and to terminals G and H of the AUXILIARY CONTROL jack.

(2) Is in the MAIN or high level output circuit (push-pull 6AQ5's). 3 watts max.

c. Low level audio output from first audio amplifier V-801 (12AU7) to pins N and I of LOCAL CONTROL jack J-1214 and pins E and F of AUXILIARY CONTROL jack J-1215.

(1) +10 dbm maximum to 600 ohm termination.

(2) Not affected by setting of A-F GAIN control.

(3) The AUDIO CT (center-tap) connections to pins G and H of LOCAL CONTROL jack (for d-c simplexing) is not likely to be used.

PROCEDURE II (Operating Adjustments)

A. Receiver R-278B

1. With receiver on work table, connect A-C power, antenna, and local control cables to receiver. Turn on A-C power to receiver.

2. Adjust receiver controls according to the Operation and Service Instruction Book, Paragraph 3-28, Page 17 - R-F GAIN switch on LOCAL. Pre-set the following frequencies, setting as indicated:

1. 257.8 mc - Will Rogers Tower
2. 363.8 mc - Tinker RAPCON
3. 225.4 mc
4. 379.4 mc
5. 255.4 mc - Will Rogers ATCS
6. 335.8 mc
7. 287.0 mc - GCA
8. 289.4 mc - GCA
9. 275.8 mc
10. 236.6 mc - Tinker Tower

Manual: 243.0 mc - UHF Emergency Frequency

B. Control Indicator, C-806/GR

1. Check control indicator by switching to each channel. (Channel Selector switch on receiver must be in REMOTE position).

2. Observe positioning action of receiver tuning gears while switching channels.

PROCEDURE III (Removal and replacement of subassemblies)

A. Frequency Selector Unit Removal

1. Set receiver on its rear, so that the front of the receiver is up.

2. Turn R-F and A-F GAIN controls to O and connect A-C power cable to receiver. (Antenna cable and local control cable are not connected to receiver)

3. SAFETY PRECAUTION - Disconnect A-C cable from receiver after tuning, but before removing or replacing frequency selector.

4. Position the frequency selector unit to 390.0 mc. In case the system has gone "dead" or is mechanically jammed, so that it is not possible to set up this frequency, record the frequency at which the frequency selector is tuned before removal and disassembly. 390.0 Oldham 257.

5. Remove twelve #4 flat-head screws and eight #6 round-head screws on the outside edge of the frequency selector unit.

6. Remove connector P-1101 from J-1211.

7. Slowly lift straight up on the released unit, being careful not to jar or scrape any of the mounted elements against the frame.

8. Retain Oldham couplers.

9. Place frequency selector unit upside down on a 4 inch prop under motor. Remove windowed front plate using tools provided and block between sections so that the dials will turn freely.

10. Connect special extension cable between unit and receiver. Apply A-C power to receiver.

11. Observe operation of unit while switching channels.

    a. Set MANUAL preset switches to 222.5 mc. Set CHANNEL 1 preset switches to 397.9 mc. Change CHANNEL SELECTOR switch to CHANNEL 1.

    b. Observe the order in which the dials commence rotating when the channel selector is switched to MANUAL.

    c. Observe the order in which the dials stop rotating when the CHANNEL SELECTOR is switched to either channel.

    d. With the CHANNEL SELECTOR on MANUAL, change the MANUAL pre-set switches one at a time.

Maximum inductance at zero and slug is all the way to the top of the coil.

IMPORTANT!!

12. Identify each switch, relay, etc., of the frequency selector unit, referring to the schematic drawing printed on the receiver cover.

13. Position the unit to 390.0 mc., remove extension cable, and replace front plate. Reinstall the frequency selector unit carefully in the receiver. See that the receiver tuning shafts are correctly positioned, and that the Oldham couplers are seated before tightening screws.

    a. After installation of unit, these three couplers are visible from the bottom of the receiver. With the frequency selector unit still set on 390.0 mc, the scribe lines on the couplers should align with the scribe lines on the indicator blocks which are attached to the receiver frame.

    b. The calibrated dial ahead of the first i-f amplifier should indicate "0" with the frequency selector unit set to 390.0 mc.

    c. The calibrated dial ahead of the frequency-multiplier amplifier should indicate "39" with the frequency selector unit set to 390.0 mc.

    d. The iron cores in the I-F transformers in the second i-f amplifier should be in the position where the greatest amount of core is in the coil. Check by using a small screwdriver as a gauge and cycling .1 mc autopositioner from .9 to .0 mc.

B. R-F Amplifier

1. Remove r-f amplifier according to the following procedure:

    a. Position frequency selector unit to 360.5 mc.

    b. Set receiver on its handles.

    c. Remove large rear plate.

    d. Remove rear plate from first i-f amplifier unit.

    e. Disconnect capacitor C-117 from pin 1 of V-401.

f. Disconnect antenna connector P-1201 from J-101.

g. Remove power connector P-101 from J-1201.

h. Remove small grounding plate connecting r-f amplifier to first i-f amplifier.

i. Remove mounting captive screws (red-headed).

j. Lift out unit. Retain the center part of the Oldham coupler.

2. Remove rear plate of unit and observe operation of tuners while rotating coupler by hand.

a. Refer to schematic diagram printed on side cover of unit and to detailed theory of operation in instruction book or course material.

(1) Note method of shielding and compartmentation.

(2) Note use of integral condensers for grounding grids of 6J4's (Pins 1, 5, 6)

3. Check internal synchronization as follows:

a. Set key of coupler in vertical position with red dot up.

b. Using this as a reference on each r-f tuner, the movable bar must line up with the stator mounting rivet (for short stator bar). This is the 360.5 mc position.

4. Do not make any adjustments without consulting instructor.

5. Do not install the r-f amplifier unit at this time.

a. When directed to reinstall r-f amplifier, have key of Oldham coupler in vertical position with red dot up and receiver frequency set to 360.5 mc.

C. Main Oscillator and Frequency Multiplier-Amplifier

1. For the purpose of familiarization, it is convenient to remove these sub-units together.

2. Position frequency selector unit to 220.0 mc.

3. Set receiver face downward on its handles.

4. Remove small grounding plate connecting frequency multiplier-amplifier to first i-f amplifier.

5. Remove solder connection between C-327 and Pin 2 of V-401.

6. Remove cable connection P-201 from J-1202.

7. Remove eight captive mounting screws (red-headed), (four each unit).

8. Do not remove connecting plate or soldered connections between main oscillator and frequency multiplier-amplifier.

9. Carefully lift the two units out together (do not try to separate). Lay on bench with gears down. Retain the Oldham couplers.

10. Remove top rear cover and right side schematic cover (as viewed from rear) of frequency multiplier-amplifier. Remove the cylindrical crystal cover of the oscillator by removing screws (3) securing cover to base by right angle brackets. Look over the construction of the units, referring to schematic diagrams on units and detailed theory of operation in instruction book or course material.

11. Check internal synchronization as follows:

    a. Set key of coupler on main oscillator in a vertical position with red dot down.

    b. With this as a reference, the crystal selector switch should be making contact with crystal #18 (220.0 mc position).

    c. For this same condition, the coil selector switch should be making contact with coil #L-222 (220.0 mc position). Hold a flashlight over the center hole of the coil cover. The switch contact for coil #22 (L-222) may be seen directly below the smaller hole between coils 22 and 39.

    d. Set key of coupler on frequency multiplier-amplifier in a vertical position with red dot up.

e. With this as a reference, the step tuner Z-301, (tapered toroid coil) must be making contact with the largest turn (last turn).

f. On each tuner, the movable contact is making contact with the end of the inductance ring and lines up with the mounting eye of the ring. (Visible by looking along bottom of tuner toward front with rear cover of unit off.) This is the 220.0 mc position.

12. Replace only round cover on main oscillator and rear cover of frequency multiplier-amplifier. Do not install the units.

a. When directed to reinstall main oscillator, have key of Oldham coupler in vertical position with red dot down and receiver frequency set at 220.0 mc.

b. When directed to reinstall frequency multiplier-amplifier, have key of Oldham coupler in vertical position with red dot up and receiver frequency set at 220.0 mc.

D. First I-F Amplifier

1. The first i-f amplifier in the R-278B receiver and the i-f oscillator unit in the T-217A transmitter are quite similar. Since the i-f oscillator unit is removed during the transmitter experiments, disassembly of the first i-f amplifier in the receiver is omitted.

2. Note that access to trimmers and cores of i-f transformers in first i-f amplifier is through the bottom of the receiver.

3. Refer to receiver schematic diagrams for location of stages, and to instruction book or course material for detailed theory of operation.

E. Second I-F Amplifier

1. Remove the second i-f amplifier according to the following procedure:

a. Set receiver in its normal position.

b. Position the frequency selector unit to 399.9 mc.

c. Remove connector P-501 from J-1205.

d. Remove connector P-502 from J-608.

(1) In order to perform step d. in the field, it may first be necessary to remove the audio amplifier unit. However, since the middle cable clamp has been removed from the units here in the school, it will not be necessary to remove the audio amplifier.

e. Release captive mounting screws (red-headed).

f. Remove unit by sliding to the rear and lifting up.

2. Remove cover. Look the unit over, referring to the schematic diagrams, and the detailed theory of operation in the instruction book or course material.

3. Check internal synchronization as follows:

a. Set key of coupler in vertical position with red dot up.

b. With this as a reference, the cam follower should be 8 degrees clockwise from the low point of the cam and the crystal switch should be making contact with crystal #10. (This is the 399.9 mc position).

4. Replace cover, but do not install unit.

a. When directed to reinstall second i-f amplifier, have key of Oldham coupler in vertical position with red dot up and receiver frequency set to 399.9 mc.

F. Third I-F Amplifier and Audio Amplifier

1. It is not necessary to remove these units at this time.

a. Removal of the third i-f amplifier will be accomlished during the alignment experiment.

2. Locate the various stages in the third i-f amplifier and audio amplifier and briefly study their principles, referring to schematic diagrams and detailed theory of operation in the instruction books or course material.

G. Power Supply Rectifier and Power Supply Filter

1. It is not necessary to remove these units.

2. Locate the distinctive features of these units, referring to schematic diagrams and the detailed theory of operation in instruction books or course material.

H. Receiver Tuning - Mechanical Drive

1. The removal of sub-units has made the intermediate gear train mechanism accessible to view.

2. Referring to Paragraphs 3-124, Pages 36-39 of the Instruction Book, or to the appropriate course material, observe the operation of the intermediate gear train and drive shafts. Note which sub-units are tuned each time. With POWER switch ON:

   a. Place the CHANNEL SELECTOR switch on MANUAL.

   b. Change the "tens" megacycle MANUAL pre-set switch to a higher number.

   c. Change the "tens" megacycle MANUAL pre-set to a lower number.

   d. Change the "units" megacycle MANUAL pre-set switch to a higher number.

   e. Change the "units" megacycle MANUAL pre-set switch to a lower number.

   f. Change the "tenth" megacycle MANUAL pre-set switch to a higher number.

   g. Change the "tenth" megacycle MANUAL pre-set switch to a lower number.

   h. Set the "units" switch to 9 and observe the position of the radius stepped periphery cam on the 1 mc shaft. Then change to 8, 7, etc to 0, 9, observing the r-f amplifier tuning shaft position at each step.

I. Assembly of sub-units

1. After checking with the Instructor, reinstall sub-units in reverse order of removal, following the applicable instructions listed above.

CAUTION: Allow a nominal clearance of .010 inch between sections of Oldham couplers when tightening captive screws.

2. To install any one of the mechanically coupled sub-units into the receiver frame, set the key of the coupler in a vertical position with red dot up (except for the main oscillator which must have red dot down) and have the receiver set to the assembly frequency for that unit. These assembly frequencies are:

Frequency Selector Unit - 390.0 mc
First and Second I.F. Amplifier - 399.9 mc
Main Oscillator - 220 mc
Frequency Multiplier-Amplifier - 220 mc
R-F Amplifier - 360.5 mc

3. Be certain to reinstall rear cover plate on first i-f amplifier.

4. Leave large rear plate off of receiver to facilitate the next experiment.

PROCEDURE IV (Mechanical Synchronization Checks)

A. Criteria for determining correct adjustment of mechanical drive system.

1. A-C Power Cable connected to receiver. Receiver POWER switch ON.

2. Make the following mechanical synchronization checks:

NOTE: The following checks are in addition to the checks made during the foregoing procedures and with them are considered sufficient for this experiment. A complete list of all mechanical checks is carried on Page 50A-50B of the Instruction Book.

a. With a frequency of xx9.9 selected, the red dots on the two couplers ahead of the first i-f amplifier should be in the up position.

b. With a frequency of xx9.9 selected, the iron cores in the i-f transformers of the first i-f amplifier should be in the position where the smallest amount of core is in the coil.

c. With a frequency of xx9.x selected, the crystal switch in the first i-f amplifier should be on position number "1" (40 mc crystal position)

d. With a frequency of xx0.x selected, the follower on the step cam in the rear gear train should be on the highest point on the cam.

e. With a frequency of 22x.x selected, the rotor bar in all four frequency multiplier-amplifier tuners should be opposite the eyelet at bottom of tuner (bar directly beneath driven shaft as viewed from top of tuner).

f. With a frequency of 390.x selected, the rotor bars in all three r-f amplifier tuners should be in a vertical position directly above their respective driven shafts.

g. With a frequency of 39x.x selected, the rotor contact of toroidal step tuner Z-301 should be on the smallest turn of the coil and should have tension holding contact against turn.

B. Operational Check

1. Connect antenna to receiver and make an operational check on one or more of the frequencies (used locally) listed in Procedure II, Paragraph A-2.

REVIEW QUESTIONS

A. Complete the applicable review questions and submit to instructor on the day following completion of the experiment.

CAA AERONAUTICAL CENTER
AIR NAVIGATION FACILITIES BRANCH
COMMUNICATIONS EQUIPMENT UNIT

UHF MILITARY EQUIPMENT LABORATORY EXPERIMENT

Name Charles G. Turner

Date 3/27/1959

R-278B RECEIVER ALIGNMENT

PURPOSE OF EXPERIMENT

The purpose of this experiment is to train the student in R-F and I-F alignment of the R-278B/GR Radio Receiver and to acquaint the student with the methods of measuring performance. In addition, it permits the student to gain experience in use of CAA test equipment and in the detection of abnormal receiver operation.

REFERENCES

Handbook of Maintenance Instructions, Radio Receivers, R-278/GR, R-278A/GR, and R-278B/GR (T.O. No. 16-350A192-3), revised June 30, 1953.

UHF Military Equipment course material

Instruction books for test equipment (as required)

Lecture Notes

EQUIPMENT REQUIRED

Receiver, Type R-278B/GR

UHF Signal Generator, Hewlett-Packard Model 608D

HF Signal Generator, Measurements Corporation Model 65B

UHF Frequency Meter, Gertsch Model FM-3

HF Frequency Meter, BC-221

Vacuum Tube Voltmeter

Output Meter, General Radio 583A

Alignment Tools

Hand Tools

2200 ohm Resistor w/clip on each end

Capacitor, .05mfd w/clip on one end

Head Set

PROCEDURE I (Alignment)

A. General Instructions

1. Because of circuit differences between the Collins equipment for which the Maintenance Handbook is written, and the Delco equipment, which we have, the schematic drawings printed on the receiver cover and sub-units and in the binder of the instruction books should be used whenever possible.

B. Preparation of Equipment

1. Remove receiver from rack. Remove dust cover and place receiver on front handles. Remove large plate on rear of receiver. Turn on test equipment and receiver and allow a warm-up period of about 15 minutes. Use this time to check test equipment and read over experiment.

C. Alignment of Third I-F Amplifier

1. Accurately adjust the 65B signal generator output frequency to 2.05 mc by zero beating it against the BC-221 Frequency Meter.

2. Adjust receiver controls as follows:

a. R-F GAIN set at 10. A-F GAIN set to 0.

b. AVC TIME CONSTANT set in COMM position.

c. AVC switch in ON position.

d. SQUELCH switch in OFF position.

3. Remove Third I-F Amplifier unit from receiver frame and remove bottom cover plate.

4. Replace electrical connections to receiver.

5. Remove V-501 from Second I-F Amplifier.

6. Connect VTVM to AVC jack, J-606, or AVC jack on front of receiver.

7. Connect signal generator output to J-603 (grid of V-603) and adjust output to maintain AVC voltage of 2.5 to 3.5 throughout alignment procedure.

8. Tune the secondary and primary (bottom and top respectively) of coils of T-604 for maximum AVC voltage.

9. Connect signal generator output to J-602 and adjust output as before.

10. Shunt the primary of T-603 (terminals 1 and 2) with the 2200 ohm swamping resistor and tune secondary (bottom) coil for maximum AVC voltage. Shunt the secondary of T-603 (Terminals 3 and 4) with the swamping resistor and tune the primary (top) coil for maximum AVC.

    NOTE: Before attaching swamping resistor, turn plate voltage OFF by operating the tracking control switch.

11. Connect signal generator to J-607 and adjust output.

12. Tune T-602 using the same procedure as in step 10.

13. Connect signal generator to J-503 and adjust output.

14. Tune T-601 using the same procedure as in step 10.

15. Leave third i-f unit out, cables connected.

16. Replace V-501 in second i-f amplifier. Remove swamping resistor.

D. Alignment of Second I-F Amplifier

1. Adjust receiver controls as follows:

    a. Same as step C-2.

    b. Tenth mc frequency set at 0.5 mc.

2. Remove V-402 and V-404 from first i-f amplifier.

3. Check operation of third injection oscillator for each 0.1 mc crystal by changing 0.1 autopositioner from .0 to .9 and measuring d-c voltage at J-504. (Should be -6.0 to -15.0 volts)

4. Connect VTVM to AVC jack, J-606, or AVC jack on front of receiver. Reset .1 mc autopositioner to .5 mc.

5. Connect signal generator to J-404 and tune the signal generator to 9.5 by maximum AVC indication. Maintain signal level to give AVC voltage of 2.5 to 3.5 volts throughout alignment procedure.

6. Studs for adjusting the slugs of the second i-f amplifier transformers are accessible through the bottom of the receiver after the third i-f amplifier has been removed.

7. Adjust the slugs of both T-501 and T-502 for maximum avc voltage. In case the signal generator does not possess enough output to give an initial avc reading before the slugs are adjusted, position the slugs one and three sixteenth inches from the tops of the shield cans when the receiver is tuned to xxx.9 mc. After this has been accomplished, an initial avc reading should be noted following which peaking of the various slugs can be accomplished with the receiver tuned to xxx.5 mc.

8. Check the sensitivity of the amplifier at each of the ten frequencies between 9.0 and 9.9 mc by observing the signal voltage required to give a fixed avc voltage. If the ratio of maximum to minimum signal input voltage is greater than 1.12 to 1 (one db), retune the transformers at a frequency which will tend to lower the change in gain. For example, if after alignment of the transformers at 9.5 mc, the gain at 9.0 mc is slightly low, realign the transformers at a slightly lower frequency of about 9.4 mc. Recheck the gain ratio over the frequency range to see that it is less than 1.12 to 1. This completes alignment of the second i-f amplifier.

9. Replace third i-f amplifier.

10. Replace tubes V-402 and V-404 in first i-f amplifier.

E. Alignment of the First I-F Amplifier

1. Align second oscillator in first i-f amplifier to the same settings as used in Step C-2.

a. Adjust receiver controls.

b. Remove tubes V-102 and V-305.

c. The studs for adjusting the slug and trimmer condenser positions are accessible from the bottom of the receiver and may be adjusted with the special tool (skirted screwdriver) supplied with the receiver.

d. With the receiver tuned to xx9.9 mc, adjust the slugs in i-f transformers T-401, T-402, and T-403, so that the distance from the top of the shield cam to the slug is 1 and 11/32 inches.

e. Connect the VTVM to J-405.

f. Set the tuning to xx9.0 mc.
Tune T-403 primary trimmer for maximum meter indication.

g. Set the tuning to xx0.0 mc. Tune T-403 primary slug for maximum meter indication.

h. Repeat this procedure until no further improvement is noted.

i. Remove plug P-402 from jack J-505, and connect the the VTVM to J-404.

j. Set the tuning to xx9.0 mc and tune T-403 secondary trimmer for maximum meter indication.

k. Set the tuning to xx0.0 mc and tune T-403 secondary slug for maximum meter indication.

l. Repeat this procedure until no further improvement is noted.

m. This completes the oscillator alignment. As the receiver is tuned to each 1.0 mc position from 9.0 to 0.0 mc, check the tuning of the primary and secondary coils with a tuning wand. The tuned circuits associated with the oscillator should be very closely in resonance at every position.

n. With the VTVM in J-405, the d-c voltage indicated should be about -2.5 volts.

2. Align i-f stages in first i-f amplifier.

   a. Set the receiver tuning to xx5.0 mc. Connect the VTVM to J-606.

   b. Inject a 45.0 mc signal from the signal generator at J-402. Adjust the frequency of the signal generator for maximum avc voltage as read on the VTVM. (Use a 50 ohm coaxial line directly coupled to the signal generator with a 47-50 ohm carbon resistor loading the output end of the coaxial line). Adjust the input to give 3 or 4 volts on the VTVM. Maintain the input to give approximately this reading as the alignment progresses.

   c. Insert the iron end of the tuning wand into the primary of T-401 and tune the secondary trimmer (C-407) for maximum output. Remove the tuning wand from the primary and insert the iron end of the wand into the secondary. Tune the primary trimmer (C-403) for maximum output.

   d. Remove the tuning wand from T-401 and insert the iron end of the wand into the primary of T-402. Tune the secondary trimmer (C-417) for maximum output. Remove the tuning wand from the primary and insert the iron end of the wand into the secondary. Tune the primary trimmer (C-414) for maximum output.

   e. Set the receiver tuning to xx0.0 mc and inject a 40.0 mc signal at J-402 from the signal generator.

   f. Insert the iron end of the tuning wand into the primary of T-401 and check the tuning of the secondary with another tuning wand. If insertion of the brass end of the tuning wand increases the output indication, adjust the secondary slug for maximum indication by turning the slug stud counterclockwise. If insertion of the iron end of the tuning wand causes only a slight increase (.5 volts avc or less) do not change the slug adjustment.

   g. If insertion of the iron slug causes a greater increase, adjust the secondary slug for maximum indication by turning the slug stud clockwise.

   h. Repeat steps e, and f, for the secondary of T-401 and the primary and secondary of T-402.

i. Set the receiver tuning to 9.9 mc. Inject a 49.9 mc signal at J-402.

j. Insert the iron end of the tuning wand into the primary of T-401 and check the tuning of the secondary with another tuning wand. If insertion of the brass end of the tuning wand increases the output indication, adjust the secondary trimmer for maximum output. If insertion of the iron end of the tuning wand causes only a slight increase (approximately .5 volts avc or less), do not adjust the trimmer. If insertion of the iron end of the tuning wand causes a greater increase, adjust the trimmer for maxumum output.

k. Repeat steps i, and j, for the secondary of T-401 and the primary and secondary of T-402.

l. Repeat steps e, to k, until no further improvement is noted.

m. Check the gain over the frequency range by noting the input required from the signal generator to give an avc reading of 4.0 volts for each 1.0 mc increment of receiver tuning from 40.0 to 49.0 mc. The ratio of the largest to the smallest value of signal input should not be more than 1.41 to 1 (3 decibels). If the gain ratio is below 3 decibels, repeat the alignment procedure until the gain ratio is below the 3 decibel maximum.

NOTE: If all the amplifier trimmer capacitors are tuned for maximum capacity, the amplifier may oscillate due to mutual coupling provided by excessive chassis currents. This condition should not exist in actual operation as the trimmers should tune approximately 10 to 18 turns out from the maximum capacity position. To avoid the above conditions, never start alignment procedure with the trimmer capacitors tuned for maximum capacity.

n. Replace tubes V-102 and V-305.

F. Alignment of Main Oscillator

1. The crystals in the main oscillator are military type CR-32/U units with a frequency tolerance of .002%.

2. The main oscillator frequency can be varied over a small range by tuning L-222 to L-239 and checking the frequency with the Gertsch FM-3 Frequency Meter.

   a. The limit of frequency variation by this method is small when oscillator reliability and maximum drive to the succeeding stages are considered.

3. For this reason, the method used in this laboratory will be to adjust L-222 to L-239 for maximum drive and then measure the frequency under this condition.

   a. Connect a VTVM to test point C-302.

   b. Set receiver frequency at 22X.X mc to tune L-222; 23X.X to tune L-223; etc, to 39X.X to tune L-239.

   c. Adjust L-222 to L-239 for maximum meter indication.

4. Remove plate voltage from the receiver by operating the TRACKING CONTROL switch located at rear of chassis to the OFF position.

5. Connect R-F cable to INPUT/OUTPUT jack of Gertsch frequency meter. Connect other end of cable to receiver chassis and to plate voltage connector at C-204 (See Fig. 5-1 of TO #16-350A192-3) through an isolating capacitor. Turn TRACKING CONTROL to ON.

6. Referring to Figure 3-3 PAGE 10 of the Maintenance Instructions, measure a crystal frequency between 30 mc and 38.8889 mc. Record crystal frequency (indicated), the actual frequency (measured), and the percent deviation of measured frequency from indicated frequency (percent error).

7. Follow tuning instructions for the Gertsch Frequency Meter for "SECTION A - To measure a frequency."

   CAUTION: Always check for "Lock-in" (frequency meter step 6) by detuning HF OSC knob A slightly in either direction. If signal in headphones changes pitch with even a slight detuning of HF OSC knob, look for another beat note with the LF OSC knob C. With the correct beat note selected, RF OSC knob may be moved 5 or 10 degrees before the signal "pops" out of zero beat.

G. Alignment of Frequency Multiplier Amplifier

1. In general, since most adjustments of the Frequency Multiplier Amplifier are made by bending, and because it is possible to check adjustments without the necessity for re-making them, by use of the tuning wand, the laboratory procedures will be confined to checking alignment unless extreme misalignment is encounted.

2. Adjust receiver controls as follows:

   a. Same as Step C-2.

   b. Frequency as indicated in the following procedure.

3. Remove screws from Frequency Multiplier Amplifier right end cover plate but leave plate in place. (Cover may be off as result of familiarization experiment)

4. Attach D-C lead of VTVM to C-309.

5. Set receiver frequency to 320.0 mc.

6. Tune step tuner, Z-301, trimmer, (See Figure 5-1, TO #16-350A192-3) for maximum voltage reading on VTVM.

7. Set receiver frequency at 390.0 mc.

8. Check step tuner tuning at 390.0 mc by sliding side cover plate upward enough to insert tuning wand near the coil.

9. If insertion of iron end increases VTVM reading, this is an indication more inductance is needed. Compress turns of coil.

10. Set receiver frequency at 320.0 mc and retune step tuner.

11. Repeat steps 7 through 10 until minimum tuning deviation occurs over frequency range. This completes tuning of Z-301,

12. Replace side cover plate.

13. Attach VTVM to J-402.

14. Check tuning of trimmer capacitors of Z-303, Z-305, Z-307, and Z-309 for maximum meter indication at receiver frequency of 380.0 mc.

15. Set receiver frequency at 390.0 mc.

16. Check tuning of each tuner by inserting tuning wand in front access hole. Remember whether iron or brass is required to increase AVC voltage of each tuner. Repeat for 310 and 220 mc. Consult with instructor as to advisability of tab bending if tuning wand produces upward deflection on VTVM at J-402 in excess of 0.5 volts. (See page 60-61 of TO #16-350A192-3). Voltage measured at J-402 should be between -0.8 and -2.5 v. for all 18 positions of 10 mc Autopositioner.

H. Alignment of R-F Amplifier

1. Adjust receiver controls as follows:

   a. Same as Step C-2.

   b. Frequency as indicated in following procedure.

2. Connect 608D signal generator output to antenna jack J-1212.

3. Connect VTVM to AVC jack, J-606, or AVC jack on front of receiver.

4. Set receiver frequency to 360.5 mc.

5. Adjust signal generator output frequency to 360.5 mc by tuning for maximum receiver AVC voltage. (Signal Generator Modulation OFF)

6. Maintain signal level to give AVC reading of about 5.0 volts.

7. Adjust R-F tuner trimmers to give maximum AVC voltage.

8. Check R-F amplifier tracking at 390.5 mc, 380.5 mc, etc., to 220.5 mc.

NOTE: Output frequency of signal generator should be changed to correspond with indicated receiver frequency, tuning for maximum AVC voltage for each tracking point checked. Signal generator output level should be maintained at value determined in step 6.

9. The tuning wand will be found to be relatively ineffective below approximately 250 mc in checking the first and second R-F stages due to the low impedance of the tank circuits of the grounded grid amplifiers. If tuning wand produces an upward deflection in excess of 1 volt (AVC on VTVM), check with instructor as to the adviseability of tab bending.

PROCEDURE II (Performance Measurements)

A. General

1. Although a slight saving of time might be effected by combining some performance tests with the alignment procedures, they are accomplished separately here in order to present them in a form more useful to the student for signal tracing or performance measurements in the field.

2. Some data obtained will be in the nature of typical readings and will vary between receivers, while others must conform to established performance criteria. Refer to Figure 5-4, Page 54, TO #16-350A192-3, for normal readings at each step.

B. Third I-F Sensitivity

1. Remove V-501 and connect Model 65B Signal Generator direct to J-503. Connect VTVM to AVC jack J-606. Refine signal generator frequency at 2.05 mc and adjust its output to produce 1.0 volt above the static voltage existing at J-606 in the absence of a signal. Record on the attached performance data sheet. Replace V-501. The required signal generator output voltage should not exceed 625 uv.

C. Second I-F Sensitivity

1. Remove V-402 and V-404 and connect Model 65B Signal Generator direct to J-404. Connect VTVM to AVC jack J-606. Set receiver tenth mc frequency to .5 mc. Tune signal generator to 9.5 mc for maximum AVC voltage, and adjust its output to produce 1.0 volt above the static voltage at J-606. Record on data sheet. The required signal generator output voltage should not exceed 72 uv. Replace V-402 and V-404.

D. First I-F Sensitivity

1. Remove V-102 and V-305. Connect Hewlett-Packard Model 608D Signal Generator direct to J-402. Connect VTVM to AVC jack J-606. Set receiver unit and tenth mc frequency to 5.5 mc. Tune signal generator to 45.5 mc for maximum AVC voltage, and adjust its output to produce 1.0 volts above the static voltage at J-606. Record on data sheet. The required signal generator output voltage should not exceed 12 uv. Replace V-102 and V-305.

E. Third Oscillator Activity

1. Connect VTVM to J-504. Record the voltage at each tenth mc step from .0 to .9 mc by changing autopositioner. Use VTVM probe containing 1-megohm resistor (D-C probe).

F. Second Oscillator Activity

1. Connect VTVM to J-405. Record the voltage at each 1 mc step from 0 to 9 mc by changing autopositioner.

G. Main Oscillator Activity

1. Connect VTVM to test point R-302, C-302. Record the voltage at each 10 mc step from 22x.x to 39x.x by changing autopositioner.

H. Frequency Multiplier Amplifier

1. Connect VTVM to J-402. Record the voltage at each 10 mc step from 22x.x to 39x.x mc by changing autopositioner.

I. R-F Sensitivity

1. Set receiver controls as follows:

a. AF GAIN to O (minimum).

b. RF GAIN to 10.

c. FREQ RESPONSE to NARROW.

d. Frequency selector unit set to 315.5 mc.

e. QUIETING control set to maximum (42 db).

f. SQUELCH switch set to ON.

2. Connect the output meter to the receiver PHONES jack. Set the output meter impedance to 600 ohms and level multiplier to 100.

3. Connect the UHF Signal Generator to the receiver antenna input.

4. Turn signal generator POWER to OFF.

5. Connect VTVM to AVC volts jack on front panel or to J-606 on Third I-F Amplifier unit.

6. Reduce R-F GAIN until CARRIER light goes out. (If CARRIER light is already extinguished, leave R-F GAIN control at maximum setting)

7. Record setting of R-F GAIN control on attached performance data sheet.

8. Turn SQUELCH switch to OFF.

9. Turn signal generator POWER switch to ON.

10. Set signal generator output to 3 microvolts, on operating frequency, with 30% modulation at 1000 cps.

11. Refine signal generator output frequency adjustment, tuning for maximum receiver power output. (It will be necessary to adjust A-F GAIN control to give output indication)

12. Adjust A-F GAIN control to produce 1.0 watt (30 dbm) indication on output meter.

13. Switch signal generator modulation selector to EXT MOD and note reading of output meter.

a. Output meter reading should drop 10 db or more. (to 20 dbm or less)

(1) If it drops more than 10 db, repeat steps 10, 11, 12 and 13, using a smaller signal input until a signal to noise ratio of 10 db is obtained.

(2) If it fails to drop 10 db, sensitivity is below normal. Check equipment and test equipment settings and connections, and if the trouble cannot be remedied, contact an instructor.

b. Record signal generator output for a signal to noise ratio of 10 db on the attached data sheet.

c. Repeat steps I-1 to I-13 for 220.0 mc and 399.9 mc, recording results on the attached data sheet.

d. The AVC voltage should not change when modulation is switched on and off, but should be greater than the AVC volts obtained with no signal (signal generator attentuator at zero).

J. Selectivity Measurement

1. Since the overall band-pass characteristic of the receiver is determined largely by the 2.05 mc Third I-F Amplifier, selectivity measurement is confined to this section.

2. Adjust 65B Signal Generator output frequency to approximately 2.05 mc with Modulation "OFF". ✓

3. Remove tube V-501.

4. Connect signal generator to J-503 and VTVM to AVC jack, J-606 or AVC jack on front of receiver. ✓

5. Refine signal generator frequency by tuning for maximum AVC voltage and adjust generator output to produce 1.0 volt AVC above the static voltage at J-606. NOTE: If double-humped response is apparent, tune signal generator frequency to minimum between humps.

6. Record AVC voltage. 4.20

7. Record the output of the signal generator. 1000

8. Advance the output of the signal generator to twice the value recorded in step 7. ✓

9. Change the frequency of the signal generator on both sides of 2.05 mc until the AVC reading is obtained as recorded in step 6.

10. Record the two frequencies. (These are the 6 db points). The difference of these frequencies should not be less than 65 kc.

11. To obtain the 60 db bandwidth, set the signal generator output to 1000 times that recorded in step 7.

12. Change the frequency of the signal generator to produce the same AVC voltage recorded in step 6. (Bandwidth should be less than 185 kc).

13. Record the 2X (6 db) and 1000x (60db) bandwidths on the data sheet.

K. Audio Power Output Measurement

1. Connect the output of the Hewlett-Packard 608D Signal Generator to the input of the receiver, antenna jack, J-1212.

2. Attach the General Radio 583A Output Meter (set for 600 ohms) to the phones jack, J-1213.

3. Adjust the settings of the signal generator to produce a 100 microvolt signal, 30% modulated by 1000 cycles, on an output frequency of 399.9 mc.

4. The receiver should produce at least three watts at the main output (PHONES jack), with the A-F and R-F GAIN controls on 10.

5. Reduce A-F GAIN control setting until output is exactly three watts. Record A-F GAIN control setting for 1000 cycles.

6. Repeat measurement using a modulation frequency of 400 cycles, again adjusting the A-F GAIN control for three watts output. Record A-F GAIN control setting for 400 cycles.

L. Carrier-Operated Relay Sensitivity Measurement

1. Connect the UHF signal generator to the antenna input.

2. Set the receiver and signal generator to a frequency of 315.5 mc.

3. Set receiver R-F GAIN to value determined in Step I-7, R-F Sensitivity.

4. Turn SQUELCH switch to ON.

5. QUIETING control set to maximum setting (42 db).

6. Advance signal generator output slowly, from minimum level, until the carrier-operated relay becomes energized (CARRIER light goes on).

7. Note output level of signal generator and record on performance data sheet. (This is the squelch threshold)

REVIEW QUESTIONS

A. Complete applicable review questions and submit to instructor on the day following completion of the experiment.

PERFORMANCE DATA

R-278B RECEIVER ALIGNMENT

R-278 Serial Number 934

Name Charles G. Turner

Date March 30, 1959

MAIN OSCILLATOR
FREQUENCY MEASUREMENT: Crystal Freq. _____ Measured Freq. _____

Frequency Error _____ %

THIRD I-F SENSITIVITY: 500 uv at J-503 for 2.8 v. AVC at J-606.

SECOND I-F SENSITIVITY: 26 uv at J-404 for 2.8 v. AVC at J-606.

FIRST I-F SENSITIVITY: 6 uv at J-402 for 3.4 v. AVC at J-606.

THIRD OSC
J-504:

.0 mc 11 v.	.1 mc 10 v.	.2 mc 11.6 v.	.3 mc 11 v.
.4 mc 11.8 v.	.5 mc 10.7 v.	.6 mc 11.7 v.	.7 mc 10.4 v.
.8 mc 10.8 v.	.9 mc 11.8 v.		

SECOND OSC
J-405:

0 mc 2.5 v.	1 mc 2.7 v.	2 mc 2.7 v.	3 mc 2.7 v.
4 mc 2.45 v.	5 mc 3.2 v.	6 mc 3.25 v.	7 mc 3.35 v.
8 mc 3.4 v.	9 mc 3.3 v.		

MAIN OSC
C-302:

22 mc 1.7 v.	23 mc 1.65 v.	24 mc 1.5 v.	25 mc 1.5 v.
26 mc 1.5 v.	27 mc 1.4 v.	28 mc 1.7 v.	29 mc 1.65 v.
30 mc 1.65 v.	31 mc 1.6 v.	32 mc 1.6 v.	33 mc 1.6 v.
34 mc 1.55 v.	35 mc 1.5 v.	36 mc 1.5 v.	37 mc 1.35 v.
38 mc 1.4 v.	39 mc 1.35 v.		

FREQ MULT AMP J-402:

22 mc .6 v.	23 mc .65 v.	24 mc .65 v.	25 mc .95 v.
26 mc 1.12 v.	27 mc 1.32 v.	28 mc 1.7 v.	29 mc 1.7 v.
30 mc 1.8 v.	31 mc 1.6 v.	32 mc 1.7 v.	33 mc 1.4 v.
34 mc 1.5 v.	35 mc 1.5 v.	36 mc 1.35 v.	37 mc 1.2 v.
38 mc 1.2 v.	39 mc 1 v.		

R-F SENSITIVITY:

@ 315.5 mc: 1.9 uv, for 10 db S/N. R-F GAIN setting 9.

@ 220.0 mc: 1.9 uv, for 10 db S/N. R-F GAIN setting 9.

@ 399.9 mc: 3 uv, for 10 db S/N. R-F GAIN setting 8.8.

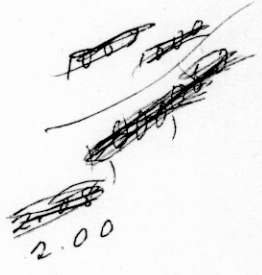
THIRD I-F SELECTIVITY: 2 X (6db) 80 kc. 1000 X (60db) 160 kc.

AUDIO POWER OUTPUT: 100 uv input, 400 cycles, 3 watt output. A-F GAIN setting 8.5.
100 uv input, 1000 cycles, 3 watt output. A-F GAIN setting 7.5.

CARRIER-OPERATED RELAY: @315.5 mc, with R-F GAIN control set to squelch on noise only:
R-F GAIN setting 8.8.
Relay operates with .45 uv input.

2.13
1.97 Hi-side
.16

2.1



CAA AERONAUTICAL CENTER
AIR NAVIGATION FACILITIES BRANCH
COMMUNICATIONS EQUIPMENT UNIT

UHF MILITARY EQUIPMENT LABORATORY EXPERIMENT

Name Charles G. Turner

Date 3/31/59

T-217A TRANSMITTER AND MD-129A MODULATOR-POWER SUPPLY FAMILIARIZATION

PURPOSE OF EXPERIMENT

The purpose of this experiment is to familiarize the student with the electrical and physical characteristics of the T-217A Transmitter and the location of subassemblies, major components, and test points. The student will become acquainted with the various controls, and learn their functions and effect. Additionally, he will acquire practice in the removal and replacement of subassemblies and perform the mechanical synchronization checks necessary to insure proper operation.

REFERENCES

Handbook Maintenance Instructions, T.O. #16-350A104-3

Lecture Notes

UHF Military Equipment Course Material

EQUIPMENT REQUIRED

Transmitter, T-217A/GR

Modulator-Power Supply, MD-129A/GR

R-F Load, 52 ohm Termaline

Tool Box with small Hand Tools

Microphone, T-17D

PROCEDURE I (Familiarization)

CAUTION: Extreme care must be used in handling Transmitter and Modulator-Power Supply units to avoid personal injury and major damage to equipment. Always use two men to handle these units and corrdinate your movements since they are quite heavy. Keep hands and feet clear to avoid serious personal injury in case of mishap. Observe usual precautions to avoid electrical shock.

A. Locate and identify controls of T-217A and MD-129A.

1. Set controls as follows:

a. NORMAL-EMERGENCY switch to NORMAL.

b. NORMAL-BROAD switch to NORMAL.

c. VOICE-MCW switch to VOICE.

d. ANTENNA SELECTOR SWITCH to OMNI-ANT.

e. CHANNEL SELECTOR (on T-217A) to "1".

f. CHANNEL 1 preset switches to 29 - 7 - .4 (297.4 mc)

g. LIMITER and AUDIO GAIN controls both to "O"

2. Identify all controls and indicators on C-806/GR Control Indicator Panel.

B. Locate and identify subassemblies

1. Modulator-Power Supply

a. Check fuses on front panel of MD-129A to ascertain the values are correct for the line voltage in use.

b. Remove A-C line power and disconnect all cables from Modulator-Power Supply.

c. Remove MD-129A from rack, turn up on handles and remove dust cover.

d. Locate:

(1) Safety interlock switches

(2) Meter fuses

(3) Safety Switch S-1411

e. Identify tubes and functions of each.

f. Replace dust cover and return modulator to rack.

2. Transmitter

a. Remove T-217A from rack, turn up on handles and remove dust cover.

b. Identify the following sections:

(1) Main Oscillator

(2) Frequency Multiplier-Amplifier

(3) I-F Oscillator Assembly

(4) Exciter

(5) Driver

(6) Power Amplifier

(7) Monitor Amplifier

(8) Servo Amplifier

C. Locate Test Points - Transmitter

1. Black phone tip jacks J-401, J-402, J-403, and J-501.

2. Condenser tabs on Multiplier-Amplifier C-302, C-308, and C-315.

3. Locate test points also on schematic diagram.

4. Locate HIGH VOLTAGE label on right side of transmitter and insulated terminal associated with it.

7. Turn AUDIO GAIN up slowly while talking into the microphone to obtain 50% modulation as indicated on the MODULATION meter.

PROCEDURE II (Removal and replacement of subassemblies)

PRECAUTION: Do not key the transmitter ON during the following procedures.

A. Removal of Monitor Amplifier

1. Remove Plug P-1301 (It may also be necessary to remove P-701)

2. Loosen four red-headed captive screws securing the chassis.

3. Lift amplifier from main chassis.

4. Examine the Monitor Amplifier.

5. Do not replace Monitor Amplifier at this time.

B. Removal of Servo Amplifier

1. Remove P-701.

2. Loosen four red-headed captive screws and lift Servo Amplifier from main chassis.

3. Remove bottom plate of Servo amplifier by removing two screws below controls and sliding bottom plate forward.

4. Examine Servo Amplifier. Note schematic and parts placement drawing on chassis and cover.

5. Replace Servo Amplifier and Monitor Amplifier. This is best done by reversing procedure for removal.

C. Removal of I-F Oscillator Assembly

1. Set transmitter frequency to 360.0 mc.

2. Disconnect cables from front panel and set transmitter on front handles.

3. Unplug P-401.

4. Remove small shield from rear end of I-F Oscillator Unit.

5. Remove two screws from outer edges of each bonding strip at rear of I-F Oscillator Unit.

6. Disconnect R-F connections to Exciter and Frequency-Multiplier Amplifier.

7. Loosen six red-headed captive screws and lift out unit. Do not lose the loose parts of the Oldham couplers.

8. Remove bottom plate of I-F Oscillator Unit on which circuit diagram is printed.

9. Observe cam and shaft arrangement for positioning slugs.

   a. Note how the coupler beneath T-401 allows the rear shaft to be moved vertically through a small range.

   b. Note which slugs are positioned by the rear shaft.

   c. Note that slugs may be screwdriver tuned from either top or bottom of chassis.

10. Note location of Switch S-1202A/B (Part of Servo System).

11. Replace I-F Oscillator Unit by following removal procedure in reverse order.

   a. The correct positioning of the shafts on I-F Oscillator is with two red dots on rear eccentrics toward each other. This is the 360.0 mc position.

   b. If couplers do not mesh, slightly rotate gears behind P-701.

D. Removal of Power Amplifier and Servo Mechanism

1. Lay transmitter on its right side and turn until the bottom side is toward you. In this position the driver subassembly is in the upper right hand corner.

2. Remove the following R-F cables and parts.

   a. Cable W-1203 (Antenna Selector Relay to Antenna Changeover Relay)

(1) Loosen "L" connector on antenna selector relay slightly and turn connector 90° clockwise to provide clearance between PA Assembly and connector during removal of PA Assembly.

b. Cable W-1202 (Antenna Changeover Relay to Directional Coupler).

c. Cable W-1201 (Low Pass Filter to P.A. Output)

d. Remove small cables and crystals from directional coupler. Crystals are marked "A" and "B" to identify correct position.

e. Remove directional coupler (four nuts).

f. Disconnect r-f input to PA grid by removing elbow.

g. Remove low pass filter. Mounting hole in lower end may be slotted to preclude necessity of removing that screw completely.

3. Remove Servo Plug P-601 and PA Plug P-602.

4. Disconnect (at insulated screw terminal) the high voltage lead from front panel jack J-1211 to terminal labeled HIGH VOLTAGE by loosening nut.

5. Remove two screws on right side of transmitter frame that fastens bracing struts to bottom of Servo mechanism.

6. Remove five large Phillips head screws that hold the PA Chassis to center section of transmitter frame. These are not captive screws and care should be taken not to drop them into transmitter.

7. Slide PA and Servo assembly out through bottom of transmitter.

8. Examine parts of transmitter exposed by removal of PA assembly.

9. Remove cover on plate side of PA assembly.

NOTE: DO NOT REMOVE PA TUBES UNLESS INSTRUCTOR IS CONSULTED. BREAKAGE OF SOCKET CLIPS MAY OCCUR UNLESS TUBES ARE REPLACED CAREFULLY AND PROPERLY.

a. Examine the plate tuning mechanism. This is identical to the PA grid tuning mechanism.

b. Note r-f coupling loop moves with shorting bar.

c. Teflon cover plate is used to concentrate air-flow through tube cooling fins.

d. Observe design of C-610 and C-611.

e. Leave PA Plate cover off until PA Assembly is replaced in a later experiment.

10. Examine Servo Mechanism

a. Note spring loading drum on Gear 0-614.

b. Note that main gear 0-605, can rotate only 180 degrees.

c. Note ratio between turning of 0-605 and Helipot R-601.

11. PA assembly is NOT replaced at this time because it restricts access to trimmer adjusting holes in i-f oscillator unit. PA assembly will be replaced after alignment of driver unit in the next experiment.

12. Other subassemblies are not removed at this time. Frequency Selector, Exciter, Driver, Frequency Multiplier-Amplifier, and Main Oscillator sub-assemblies are also removable. Removal of the Frequency Selector Unit is accomplished during the receiver experiments and therefore will not be done in the transmitter experiment since the Frequency Selector Units are identical and interchangeable. Removal of the other subassemblies is not complicated and does not expose as much of the interior of the transmitter as does removal of the I-F Oscillator and PA Assemblies. Moreover, removal of these assemblies involves removal of a number of soldered connections which when done frequently (as would be the case with these laboratory transmitters) would result in rapid deterioration of wiring and components. Detailed procedures for removal of these subassemblies is given in the Instruction Book.

PROCEDURE III (Mechanical Synchronization Checks)

A. Criteria for determining correct adjustment of Mechanical Drive System.

1. Reconnect power supply cable.

2. Remove High Voltage cable at MD-129A and terminate high voltage output of MD-129A with "D-C Dummy Load". This removes high voltage from PA tubes. It will not be necessary to reconnect this high voltage cable until the latter part of the next experiment when tracking of the PA Plate circuit is accomplished.

3. Do not key transmitter plate voltage ON during these checks.

4. Since some of the following mechanical checks may be difficult to locate for the first time, the instructor will be available for assistance.

5. Make the following mechanical synchronization checks:

a. With a frequency of 390.0 mc selected, and the transmitter laying on its side, the Oldham couplers between the frequency selector and the transmitter proper are visible from the bottom of the unit. The scribe lines on these couplers should line up with the scribe lines on blocks attached to the front gear plate at a frequency of 390.0 mc.

b. With the transmitter in the normal position (bottom down), and a frequency of xx0.x selected, the calibrated dial ahead of the i-f amplifier should indicate "0".

c. With a frequency of xx9.9 selected, the iron cores in transformers Z-401, T-401, T-402, and T-403 should be in the position where the least amount of core is in the coil.

d. With a frequency of xx5.x selected, the rotary crystal switch in the h-f oscillator of the i-f oscillator section should be on crystal number "5". Replace compartment cover.

e. With a frequency of xxx.5 selected, the rotary crystal switch in the 1-f oscillator of the i-f oscillator section should be on crystal number "6". Replace crystal compartment cover.

f. With a frequency of xx0.x selected, the cam follower which rides on the step cam in the rear gear train should be on the highest point of that cam.

g. With a frequency of 39x.x selected, the calibrated dial ahead of the frequency multiplier-amplifier should indicate "39".

h. With a frequency of 22x.x selected, the coil selector switch in the main oscillator unit should be making contact with coil #L-222. Hold a flashlight over the center hole of the coil cover. The switch contact for coil #22 (L-222) may be seen directly below the smaller hole between coils 22 and 39.

i. With a frequency of 22x.x selected, the crystal switch in the main oscillator should be making on crystal #18. Replace crystal oven cover.

j. With a frequency of 360.5 selected, the rotor bar on frequency multiplier-amplifier, exciter, and driver tuners should be aligned with the short stator bar.

k. With a frequency of 390.5 selected, the rotor bar on frequency multiplier-amplifier, exciter, and driver tuners should, with the exception of Z-103, bisect the access hole. Z-103 rotor bar should be 90° from the access hole and toward Z-102.

l. With a frequency of 39x.x selected, and the side (schematic) cover of the frequency multiplier-amplifier removed, the wiper on the toroidal tuners (step tuners) should be centered on the smallest winding with gear shoulder against direction of rotation. Leave cover off until later.

6. While the foregoing mechanical checks are sufficient for this experiment, a complete table of mechanical checks may be found on Pages 61-62 of the Instruction Book.

REVIEW QUESTIONS

A. Complete applicable review questions and submit to instructor on the day following completion of the experiment.

CAA AERONAUTICAL CENTER
AIR NAVIGATION FACILITIES BRANCH
COMMUNICATIONS EQUIPMENT UNIT

UHF MILITARY EQUIPMENT LABORATORY EXPERIMENT

Name _____

Date _____

T-217A TRANSMITTER ALIGNMENT

PURPOSE OF EXPERIMENT

The purpose of this experiment is to train the student in the proper methods of alignment, tracking, adjustments, and tests required to insure proper operation of the T-217A transmitter. In doing so, he will acquire a more detailed knowledge of the operation of the circuits involved and become familiar with the troubleshooting techniques required.

REFERENCES

T. O. #16-350A104-3, Handbook Maintenance Instruction T-217A/GR and MD-129A/GR

Lecture Notes

UHF Military Equipment Course Material

EQUIPMENT REQUIRED

Transmitter, T-217A/GR

Modulator-Power Supply, MD-129A/GR

R-F load, 52 ohm Termaline

Vacuum Tube Voltmeter

Kit of hand tools with special alignment tools

RG-8/U connecting cables and fittings

PROCEDURE

The alignment and tracking procedure given in the Instruction Book presupposes that the initial adjustments are not even approximately correct; i. e. some of the circuits may be set where they will have greater response to an undesired signal than to the desired one.

Therefore, in each case preliminary mechanical settings are described by which it is supposed to insure that each circuit will have maximum response to the desired signal. After these preliminary mechanical settings, all adjustments are refined to produce the desired electrical indications. This procedure is so detailed as to obscure the principle steps of the alignment and tracking procedure. Moreover, it has been found that, at least in some cases, the preliminary mechanical settings did not result in greater response to the desired signal than to some undesired signal. For the foregoing reasons, and since the transmitters in the laboratory are already approximately aligned and since this is the situation usually found in practice, the following procedure omits the preliminary mechanical settings and proceeds with the final adjustments in each case. After having accomplished the abridged procedure one or more times a person is in a better position to go through the complete procedure without becoming lost in detail.

A. Preliminary Conditions

1. P. A. Assembly is removed from transmitter (in Familiarization Experiment)

2. Replace Directional Coupler temporarily in transmitter. Replace cables, W-1203 and W-1202. Connect E-1209 (Driver Output) to P-1203 (Directional Coupler Input) by use of a junction UG-29/U.

3. Connect D-C Dummy Load to High Voltage Jack, J-1408, (marked TRANSMITTER on front panel) on Modulator-Power Supply.

4. Connect MAIN POWER cable between Transmitter and Modulator.

5. Connect R-F Dummy Load to OMNI ANTENNA jack on front of transmitter.

B. Main Oscillator Alignment

1. Since the method of adjusting the Main Oscillator is identical in the multi-channel transmitter and receiver, and since it is accomplished in the receiver experiments, it is omitted here.

C. Frequency Multiplier-Amplifier Alignment

IN THIS OR ANY OF THE FOLLOWING ALIGNMENT PROCEDURES, IF IT IS DETERMINED THAT BENDING OF TRIMMER INDUCTANCES OR CONDENSER TABS IS REQUIRED, CONSULT INSTRUCTOR BEFORE ATTEMPTING SAME.

1. Remove side cover from Z-301 and Z-302. (See Fig. 6-10)
2. Turn main POWER switch ON. Connect VTVM to C-308 and when set has reached operating temperature, apply Plate Voltage.
3. Set Frequency Selector to 300.0 mc.
4. Adjust trimmer capacitor of Z-301 for maximum indication on VTVM.
5. Set Frequency Selector to 390.0 mc.
6. Place one end of a tuning wand close to the small trimmer coil associated with Z-301 and note change (if any) in VTVM indication.
7. Place other end of tuning wand close to trimmer coil and again watch for change in VTVM.
8. If VTVM deflection does not increase when either end of tuning wand is inserted tracking is satisfactory. If insertion of brass end of tuning wand causes an increase in deflection the trimmer coil should be extended in length (less inductance); if insertion of iron end of tuning wand causes an increase in deflection the trimmer coil should be compressed (more inductance).
9. If trimmer coil is stretched or compressed repeat steps 3 through 8 until indication of satisfactory tracking is obtained.
10. Disconnect VTVM from C-308 and connect it to C-315.
11. Repeat steps 3 through 9, this time aligning Z-302 rather than Z-301.
12. Replace side cover on Z-301 and Z-302.
13. Disconnect VTVM from C-315 and connect to J-403. Remove V-405 and disconnect B plus voltage from V-406, by removing red and white wire from terminal E-429 (near T-403 on top of chasis)
14. Set frequency selector to 360.5 mc.
15. With a fiber screwdriver, adjust the trimmer capacitors associated with Z-304, Z-306 and Z-308 for maximum VTVM deflection.
16. Set Frequency Selector to 390.5 mc.

17. Check for tracking by inserting first one end and then the other of the tuning wand in the front (small) hole of Z-304, Z-306, and Z-308 while watching for any change in VTVM deflection. If VTVM deflection does not increase in any case the tracking at this frequency is satisfactory.

18. Repeat step 17 for frequencies of 320.5, 280.5 and 220.5 mc.

19. If tracking is satisfactory at these frequencies and if voltage at J-403 (with V-405 removed and B plus removed from V-406) is more than 5 volts for all 18 positions of the 10 mc preset switch, tracking of Z-304, Z-306, and Z-308 is satisfactory for all frequencies. If it is found that tracking adjustments are required it will be necessary to follow the complete adjusting procedure given in Section 6-19, Paras. m. through r. of the instruction book.

D. I-F Oscillator Alignment

1. Replace V-405 but leave B plus to V-406 disconnected.
2. Remove V-305 and V-101.
3. Set Frequency Selector to 390.0 mc and connect VTVM to J-402.
4. Insert first one end and then the other of a tuning wand into the hole on top of Z-401. If the VTVM reading increases in either case adjust L-405 for maximum indication on VTVM.
5. Set frequency selector to 399.0 mc.
6. Insert first one end and then the other of the tuning wand into the hole on top of Z-401. If the VTVM reading increases in either case adjust C-433 for maximum indication on VTVM.
7. Repeat steps 3 through 6 until insertion of either end of tuning wand at either frequency does not cause an increase in the VTVM reading.
8. The VTVM reading for all 10 positions of the 1.0 mc Preset switch should be -2 to -4 volts.
9. Remove VTVM from J-402 and connect to J-401.
10. The VTVM reading for all 10 positions of the 0.1 mc Preset switch should be -10 to -25 volts.

11. Remove VTVM from J-401 and connect to J-403.

12. Set Frequency Selector to 399.0 mc.

13. Insert first one end and then the other of tuning wand into each of the two holes on top of T-401, T-402, and T-403 (first primary and then secondary) in that order and watch for any change in VTVM reading. If the VTVM deflection increases in any case, adjust the corresponding trimmer capacitor for mzximum deflection of the VTVM.

NOTE: In most cases only a slight adjustment of these capacitors is necessary. Using a tuning wand to determine which of the units need adjustment will help in obtaining a reading at J-403. When such an indication is available, determine that tuning is at the proper frequency by removing V-402. The voltage at J-403 should drop to Zero, indicating that the transformers are tuned to the sum of the high and low frequency oscillators. Replace V-402 and proceed.

14. Set Frequency Selector to 390.0 mc.

15. Insert first one end and then the other of a tuning wand into the primary and then the secondary of T-401, T-402, and T-403, in that order while watching VTVM for any change in deflection. If the VTVM increases in any case adjust the corresponding slug for maximum indication on the VTVM.

16. Repeat steps 12 through 15 until insertion of either end of the wand at either frequency into any of the six holes does not cause an increase in the VTVM deflection.

17. Replace tubes V-101 and V-305 and connect B plus to V-406.

E. Exciter Alignment

1. Remove VTVM from J-403 and connect it to J-501.

2. Set Frequency Selector to 360.5 mc.

3. With a fiber screwdriver, adjust the trimmer capacitors associated with Z-101, Z-102, and Z-103, for maximum deflection of VTVM.

4. Set the Frequency Selector to 399.9 mc.

5. Check for tracking by inserting first one end, and then the other of a tuning wand in the front (small) hole of Z-101, Z-102, and Z-103, while watching for any change in VTVM deflection. If VTVM deflection does not increase in any case, the tracking at this frequency is satisfactory.

6. Repeat step 5 for frequencies of 320.5, 280.5, and 220.5 mc.

7. If tracking is satisfactory at these frequencies and if voltage at J-501 is between 1.2 and 8.2 volts for all 18 positions of the 10 mc Preset Switch, tracking of Z-101, Z-102, and Z-103, is satisfactory at all frequencies. If it is found that tracking adjustments are required it will be necessary to follow the complete adjusting procedure given in Section 6-27, paras. k. through n. of the instruction book. (See Instructor)

F. Driver Alignment

1. Driver output is still terminated in 52 ohm R-F load (through Directional Coupler, Z-1202, Antenna Selector Relay, K-1204, and Antenna Jack on front panel). As the Driver output is patched through the Directional Coupler, the Driver output power may be read on the Power Output Meter on the Transmitter front panel.

2. Set Frequency Selector to 360.5 mc and turn on plate voltage.

3. With a small screwdriver, tune trimmer capacitors associated with Z-501, Z-502, and Z-503, for maximum Driver power output.

4. Set Frequency selector to 399.9 mc.

5. Check for tracking by first pushing, and then pulling the tuning screws on Z-501, Z-502, and Z-503, while watching RF power indicator for any change in output. The movable plates of the trimmer capacitors are mounted on flexible straps so that pushing or pulling increases or decreases the trimmer capacity and when the force is released the capacity returns to normal. A SPECIAL TOOL IS AVAILABLE FOR PUSHING AND PULLING ON THE TRIMMER CAPACITORS. USE IT. If the Driver output does not increase in any case when pushing or pulling on the trimmers, the tracking at this frequency is satisfactory.

6. Repeat step 5 for frequencies of 320.5, 280.5, and 220.5 mc.

7. If the tracking is satisfactory at these frequencies and if the output is at least 10 watts for all of the 18 positions of the 10 mc Preset Switch the tracking is satisfactory at all frequencies. If it is found that tracking adjustments are required it will be necessary to follow the complete procedure given in Section 6-30 of the instruction book. (See Instructor)

G. Adjustment of Servo Amplifier

Before proceeding with Servo Amplifier and P. A. Adjustments, turn off main power, disconnect main power cable and replace P. A. Assembly which was removed in the familiarization experiment. To replace P. A. Assembly, follow removal procedure in reverse order. After replacing P. A., reconnect main power cable (High Voltage is still terminated in D.C Dummy Load) and turn on main power.

1. Perform the following Servo mechanical checks:

   a. Referring to figures 6-9 and 3-13 of Instruction Book, examine the position of the plate shorting bars in the P. A. Assembly when the Frequency Selector is at 390.2 mc. The wiping fingers closest to the tubes should be within 1/8" of, and behind the second support pin (from tube holder) that attaches plate line to dielectric support. While this check applies to both the grid and plate shorting bar, only the above check will be made at this time.

   b. Replace P. A. cover plate.

2. Set the 4 potentiometer adjustments on the Servo Amplifier to extreme CCW position.

3. Increase AMPLIFIER GAIN to about 1/2 maximum.

4. Adjust AMPLIFIER PHASE for maximum torque on the two thin driving gears on the Servo drive. Amount of torque can be gauged by displacing the thin driving gears a small amount from the null point and holding them displaced with a finger.

5. The system should now "hunt" if the channel is reset or if the Servo drive gears are displaced from neutral position by hand and released abruptly.

6. Turn DAMPING GAIN about 30 degrees clockwise.

7. Turn DAMPING PHASE slowly through its entire range and observe whether or not hunting ceases at any setting of DAMPING PHASE.

8. If hunting cannot be stopped in Step 7, advance DAMPING GAIN a little more CW (about 10 degrees) and repeat Step 7. Continue this procedure until hunting is just eliminated. Too much DAMPING GAIN will result in sluggish operation and too little will result in excessive oscillation before gears come to rest. With correct adjustments of DAMPING GAIN and DAMPING PHASE the Servo gears should pass through the NEUTRAL point not more than 2 or 3 times before coming to rest.

9. It would seem that the AMPLIFIER PHASE and DAMPING PHASE controls could be set more accurately by use of an oscilloscope. However, the foregoing procedure is the same as that given in the instruction book, so apparently it is satisfactory.

H. Power Amplifier Alignment

1. Synchronize the Servo Amplifier with the Power Amplifier frequency.

   a. Set the 360 wiper of R-1205 (on side of transmitter) in a vertical position.

   b. Set the frequency selector unit to 360.2 mc.

   c. Loosen coupler between Servo Drive and P. A. gear train. (Use #8 long-handled Bristo wrench provided with equipment). It will be necessary to remove the small schematic cover plate in order to permit access to this coupler.

   d. Key transmitter ON.

   e. Manually rotate the P. A. gear train (accessible from the top of the transmitter) until maximum PA GRID CURRENT is indicated on the meter.

   f. Recouple servo drive to P. A. gear train. Replace schematic cover plate.

   g. Cycle frequency selector unit and check to see that servo has reset P. A. to maximum grid current position at 360.2 mc.

2. Align Servo Amplifier electrical input system.

   a. Adjust the contacts on R-1205 in order, setting the frequency selector unit at each 10 megacycle point (399.9 mc, 390.2, 380.2.....etc, to 220.2 mc) while adjusting the corresponding sliding contact on R-1205 for maximum grid current.

3. Turn POWER switch to OFF.

4. Disconnect High Voltage output of Modulator from D-C Dummy Load, and connect it to High Voltage jack on Transmitter.

5. Turn POWER switch to ON.

6. Apply plate voltage and check SWR as rapidly as possible (it will be necessary to adjust SWR CALIBRATE before reading SWR). If the SWR is greater than 2.5, turn off plate voltage immediately and check to see that P. A. output is correctly connected to R-F Dummy Load. If output is correctly loaded, the SWR should not exceed 2.5.

   NOTE: WHEN HIGH VOLTAGE IS APPLIED TO P. A. DO NOT LET THE P. A. PLATE CURRENT EXCEED 450 MA. WHEN MAKING ANY ADJUSTMENTS.

7. Control over the P. A. screen voltage (and thereby P. A. plate current) is provided by means of R-608 (Screen Control Pot.)

   a. Turn R-608 to the extreme counterclockwise position. This is the minimum screen voltage position and is the setting used here at the school to increase tube life.

   b. The following procedure for setting R-608 is printed on the transmitter, but is <u>not</u> to be used here at the school.

      (1) Adjust R-608 for 290 milliamperes of P. A. plate current with V-406 (in I-F Oscillator section) removed from its socket. (This removes excitation to the P. A. stage).

8. Readjust the contacts on R-1205 at 220.2 and 399.9 mc for maximum P. A. grid current.

9. Change the meter switch to Power Output, set the frequency selector unit to 220.2 mc, and adjust capacitors C-610 and C-611 for maximum power output. (Maintain equal adjustments on both capacitors in arriving at maximum power output in order to retain P. A. Plate circuit balance).

10. Set frequency selector unit to 399.9 mc, loosen the coupler holding the grid tank to the power amplifier gear train, key the transmitter, and manually move the power amplifier

gear train (accessible from the top of the transmitter) until maximum power output is indicated on the front panel meter. (Note: Since the grid tank is held stationary by the servo gear train, only the plate tank is moved by moving the power amplifier gear train.)

CAUTION: Since it is possible to damage the shorting bar by setting it too close to the tube end of the lines, the cover should be removed from the P. A. following this step and the physical position of the shorting bar checked. Replace the cover on the P. A. before continuing the procedure.

11. Re-tighten the coupler holding the grid tank to the Power Amplifier gear train.

12. Repeat steps 9, 10, and 11 until both maximum power output and maximum P. A. grid current are obtained at the same point.

13. Readjust the contacts on R-1205 in order at each 10 megacycle point for maximum power output. (399.9 mc, 390.2, 380.2.,.etc to 220.2 mc). If the preceding steps are followed carefully, little or no movement of the R-1205 contacts will be required. This indicates that grid and plate tanks are very closely synchronized.

    a. The P. A. plate current should be between 350 and 450 ma. across the entire frequency range.

    b. Minimum P. A. plate current may not occur at the setting of R-1205 which produces maximum power output. Should this condition exist, it may be necessary to compromise the final tuning adjustment in order to obtain the required 100 watts output without exceeding the maximum P. A. plate current limitation of 450 ma.

    c. If at any 10 mc point the peak grid current and maximum power output are not close, it is probable that the contacts are not making properly at all points along the line, or that the line is dirty. The position of the short circuit established by each of the shorting bars determines the resonant frequency of the parallel line tank and they must make positive contact to the lines at all times to insure power output and reset accuracy.

14. Using the attached meter reading form, take a complete set of meter readings for this transmitter.

15. This completes testing and alignment of the transmitter. Have an instructor check operation of transmitter before replacing cover and returning unit to rack.

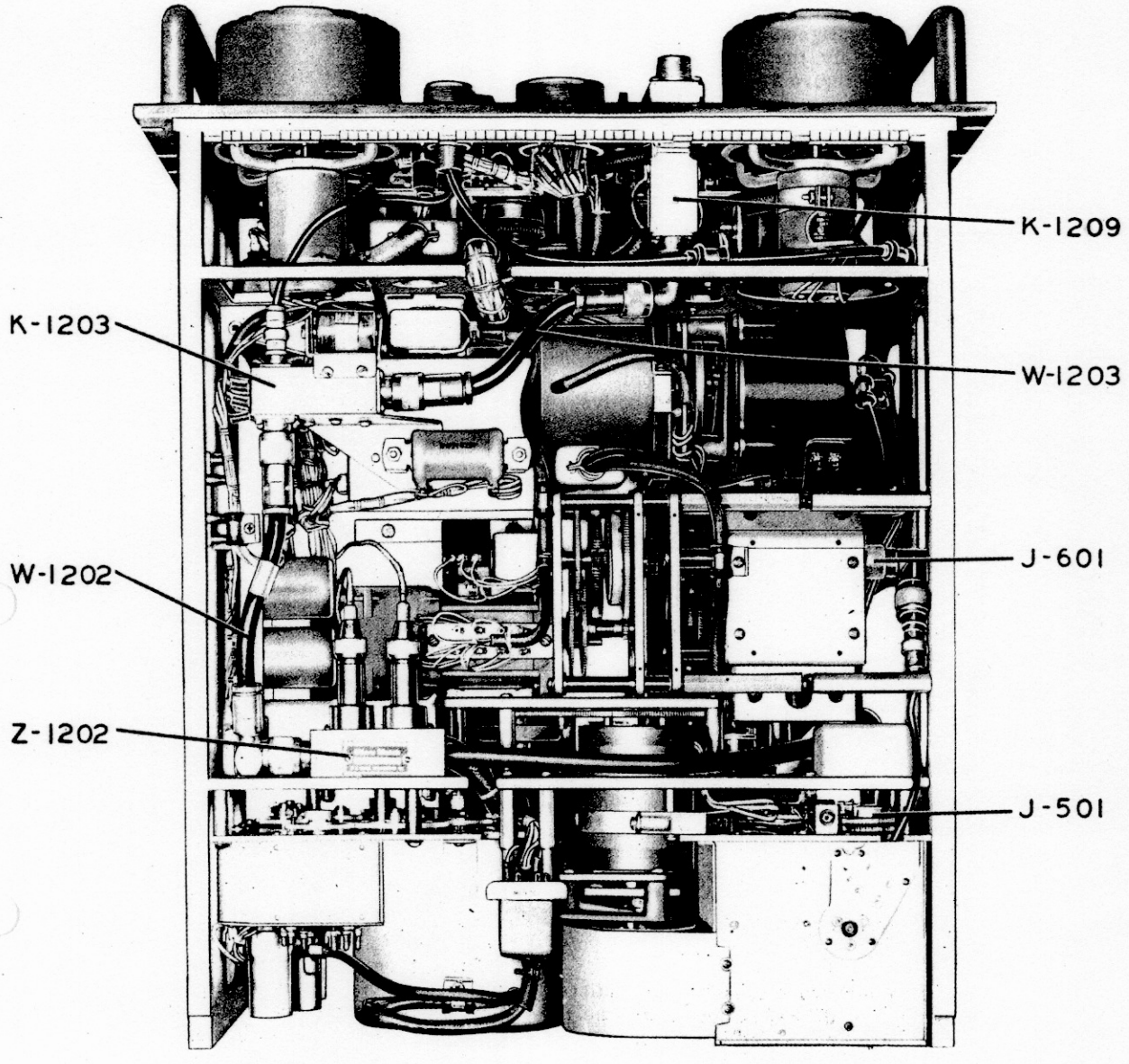
REVIEW QUESTIONS

A. Complete applicable review questions and submit to instructor on the day following completion of the experiment.

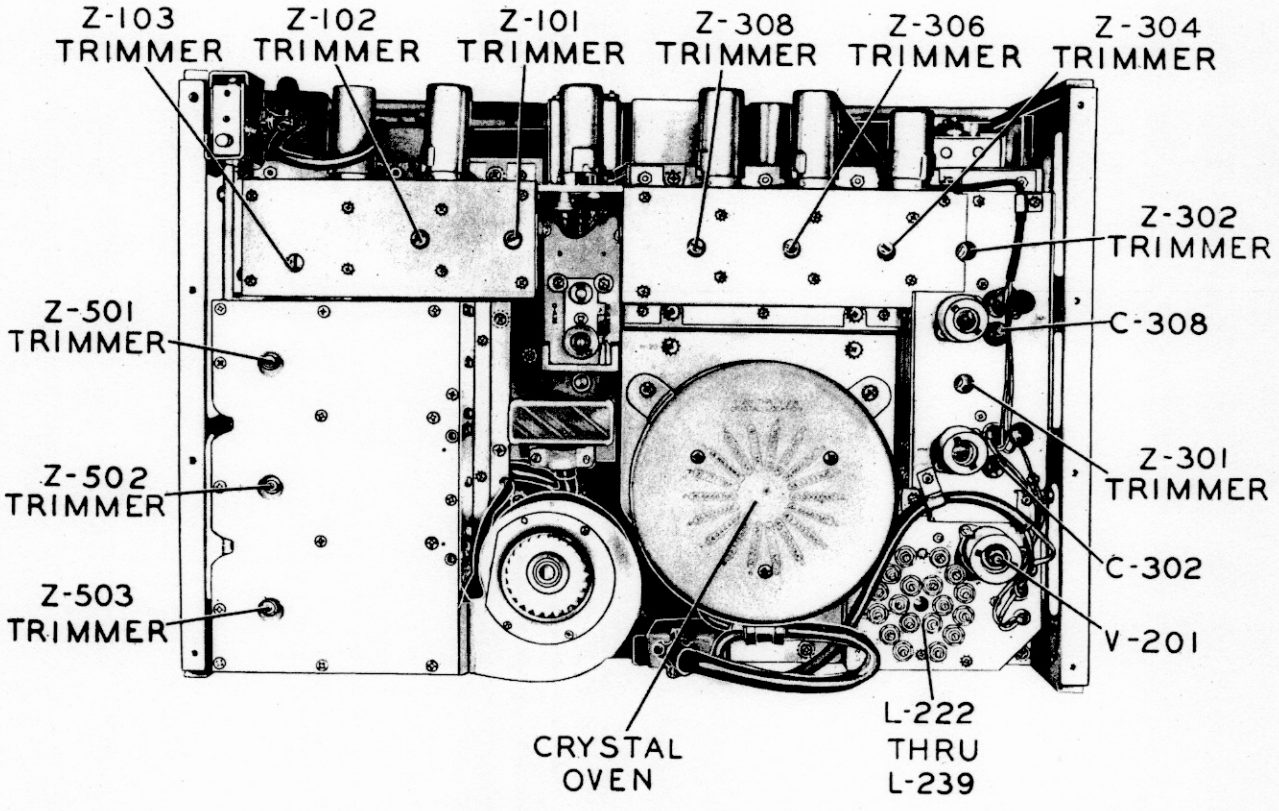
RECORD OF METER READINGS AND ADJUSTMENTS

Name Charles G. Turner Date 4/1/59

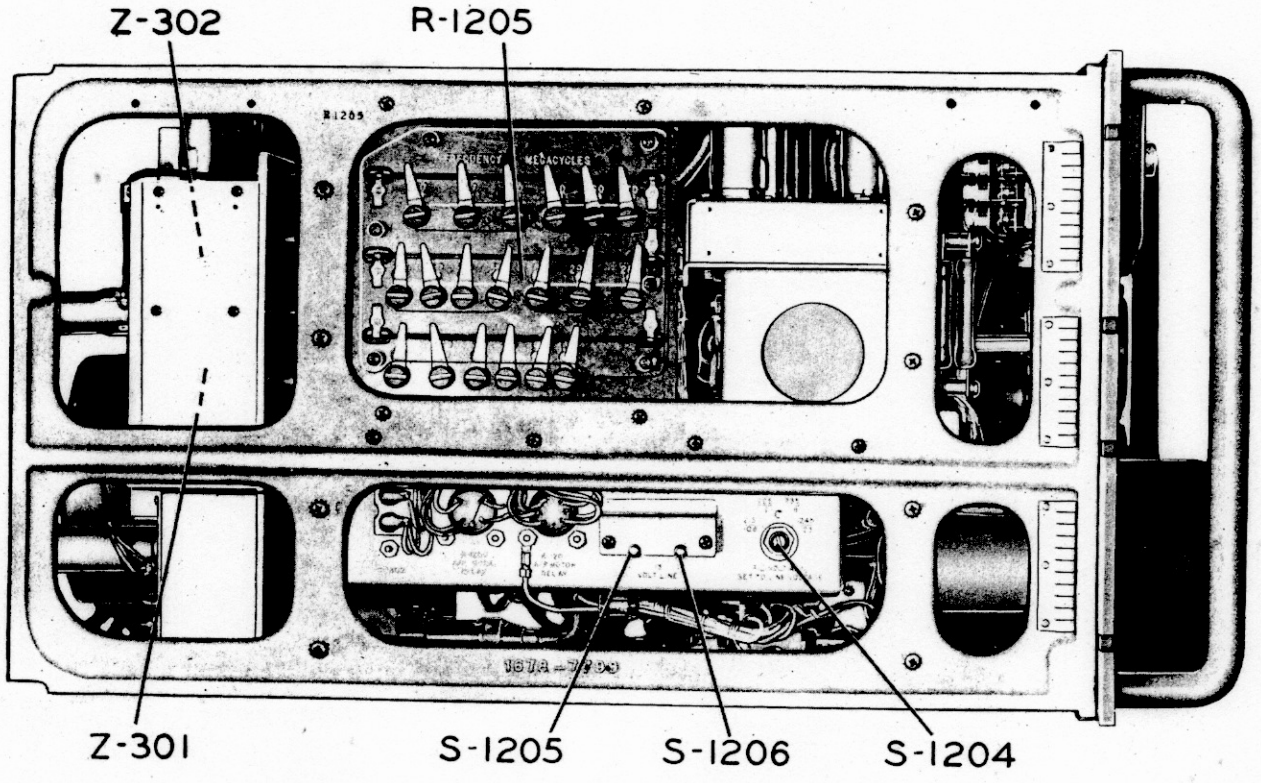
Transmitter Serial Number	917
Output Frequency	(305.5 mc except as indicated below)
A-C Line Voltage	235
CIRCUIT	METER M-1401 (Modulator)
Modulator Plate (without modulation)	60 ma.
P. A. Plate	450 ma.
Driver Plate	60 ma.
Amplifier Plate	42 ma.
Audio Gain Setting	8
	METER M-1201 (Transmitter)
Second Driver Grid	17 ma.
Third Driver Grid	25 ma.
P. A. Grid	3.2 ma.
SWR	1.0
Power Output, watts (305.5 mc)	105 watts
Power Output, watts (220.0 mc)	140 watts
Power Output, watts (399.9 mc)	110 watts



Transmitter T-217/GR, Bottom View



Transmitter T-217/GR, Rear View



Transmitter T-217/GR, Right Side View

Tip for correct Osc. i-f alignment

i-f Oscillator alignment can be done with a Signal Gen. by injecting the appropriate frequency into V-401-3.5+ disable both oscillators V-402+404, VTVM at test point J-403

i-f frequency of the T-217 is 20.0 mcs. plus X.X, so the freq. for reference at this point is 399.0 so add XX9.0 to 20.0 and the freq. that the i-f's are tuned you would be 29.0 mcs. pulling the low freq. osc. V-402 should cause reading at J-403 to drop

low freq. osc 0.1 mc freq = 1.994 plus 0.X
1.0 mc osc freq = 18.006 plus X.0
i-f freq = 20.0 mc. plus X.X