DEPARTMENT OF THE ARMY TECHNICAL MANUAL

FIELD AND DEPOT

MAINTENANCE MANUAL

RADIO RECEIVER R-390A/URR

This copy is a reprint which includes current pages from Changes 1 through 4.

HEADQUARTERS DEPARTMENT OF THE ARMY

8 December 1961

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Be careful when working on the 240-volt power supply and the circuits connected to it, or on the 115/ 230-volt alternating current line connections. Before connecting the receiver to an ac source, be sure that the chassis is connected to the same ground as the a(t source.

RADIOACTIVE TUBES

Before handling or disposing of defective voltage regulator tubes OA2WA and OA2WB refer to TB SIG 225, Radioactive Election Tube Handling.

DON'T TAKE CHANCES!

Changes in force: C1, C2, and C4

Change NO. 4

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, 1 January 1988

Direct Support, General Support, and Depot Maintenance Manual
RADIO RECEIVER R-390A/URR
(NSN 5820-00-538-7555)

TM 11-5820-358-35, 8 December 1961, is changed as follows:
Paragraphs 1.1, 1.2, 1.3 and 1.4 are changed as shown below.

1-1. Consolidated Index Of Army Publications And Blank Forms Refer to the latest issue of DA Pam 25-30 to determine whether there are new editions, changes or additional publications pertaining to the equipment.

1-2. Maintenance Forms, Records And Reports

a. Reports of Maintenance and Unsatisfactory Equipment. Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA Pam 738-750, as contained in Maintenance Management Update.

b. Report of Item Packaging Discrepancies. Fill out and forward SF 364 (Report of Discrepancy (ROD)) as prescribed in AR 735-11-2/DLAR 4140.55/SECNAVINST 4355.18/AFR 400-54/MC04430.3 J.

c. Transportation Discrepancy Report (TDR) (SF 361). Fill out and forward Transportation Discrepancy Report (TDR) (SF 361) as prescribed in AR 55-38/NAVSUPINST 4610.33C/AFR 75-18/MCO P4610.19D/DLAR 4500.15.

1-3. Reporting Errors and Recommending Improvements

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, or DA Form 2028 (Recommended Changes to Publications and Blank Forms) direct to:
Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: AMSELLC-ME-PS, Fort Monmouth, New Jersey 07703-5000.

* This Change supersedes C3, 27 May 1980.

1-4. Reporting Equipment Improvement Recommendations (EIR)

If your equipment needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design or performance. Put it on an SF 368 (Product Quality Deficiency Report). Mail it to:
Commander, U.S. Army Communications Electronics Command and Fort Monmouth, ATTN:
AMSEL-PA-MA-D, Fort Monmouth, New Jersey, 07703-5000. We'll send you a reply.

Page 159, paragraph 105a. Delete Radio Test Set AN/URM-26A from test equipment column of chart and substitute Radio Test Set AN/USM-26A.

Page 159, paragraph 106. Change warmup period from "3 hours" to 15 minutes.

Page 160, paragraph 106. In the position column, change the control setting of OVENS control from "OFF" to ON.

Page 160, paragraph 109j. Delete all of step j. and substitute:

j. Increase Signal Generator Output above the reference level by amount indicated on table and then detune the Signal Generator until the diode load voltage again reads (-5) volts. The Bandwidth shall be NMT the specified amount.

BANDWIDTH switch (kc)	Specific standard (DB)	Deviation (not more than) (kc)
1	6	1.5
1	20	3.0
1	40	5.0
16	6	16.0
16	20	19.5
16	40	24.0

Page 161, paragraph 111. After subparagraph i., and in conjunction with local audio tests, add the following note:

NOTE

BREAK IN switch ON. Ground TB-103 pin 9. BREAK IN relay is activated. LOCAL AUDIO output shall be less than 10 vac.

Page 162, paragraph 113c., line 1. Delete minus sign in front of 5 uv.

Page 162, paragraph 115a. Delete 'minimum backlash error by tuning to the test frequency from the low-frequency side " and substitute: tune the receiver in both directions without overshoot to the frequency being checked.

Page 162, paragraph 115b.(4). Delete step (4) and substitute: (4) Zero-beat the signal generator with the receiver.

Page 163, paragraph 115c.(4), line 1. Delete 4 kc and substitute 600 Hz.

Page 183, APPENDIX - REFERENCES. Delete APPENDIX - REFERENCES and substitute:

APPENDIX
REFERENCES

The following is a list of references available and applicable for direct support, general support, and depot maintenance of Radio Receiver R-390A/URR.

AR 310-25	Dictionary of United States Army Terms.
DA Pam 25-30	Consolidated Index of Army Publications and Blank Forms.
DA Pam 738-750	The Army Maintenance Management System (TAMMS).
TM 11-1214	Instruction Book for Oscilloscope OS-8A/U.
TM 11-5120	Frequency Meters AN/URM-32 and AN/UJRM-32A and Power Supply PP-1243/U [TO 33A1-5-65-1].
TM 11-5511	Electronic Multimeter TS-505/U [TO 33A1-12-55-1].
DT 11-5540	Electric Light Assembly MX-1292/PAQ (NSN 6625-00-378-5449).
TM 11-5551B	R.F. Signal Generator Set AN/URM-25B.
TM 11-5551C	R.F. Signal Generator Set AN/URM1-25C.
TM 11-5551D	R.F. Signal Generator Set AN/URM-25D [TO 33A1-8-12 1].
TM 11-5551F	R.F. Signal Generator Set AN/URM-25F.
TM 11-5820-358-10	Operator's Manual: Radio Receiver R-390A/URR.
TM 11-5820-358-20	Organizational Maintenance Manual: Radio Receiver R-390A/URR (NSN 5820-00-538-7555) [TO 31R1-2URR-442].
TM 11-5820-358-20P	Organizational Maintenance Repair Parts and Special Tools List for Radio Receiver R-390A/URR (NSN 5820-00-538-7555).
TM 11-5820-358-34P	Direct Support and General Support Maintenance Repair Parts and Special Tools List (Including Depot Maintenance Repair Parts and Special Tools) for Radio Receiver R-390A/URR (NSN 5820-00-538-7555).
TM 11-6625-203-12	Operation and Organizational Maintenance Manual for Multimeter AN/URM-105 and AN/URM-105C (Including Multimeter ME-77/U and ME-77C/U).

TM 11-6625-239-12	Operator's and Organizational Maintenance Manual for Electronic Multimeter TS-505A/U and TS-505B/U and Multimeters TS-505C/U and TS-505D/U.
TM 11-6625-252-15	Operator, Organizational, Direct Support, General Support, and Depot Maintenance Manual: Oscilloscopes OS-8B/U, OS-8C/U and OS-8E/U.
TM 11-6625-255-14	Operator's, Organizational, Direct Support and General Support Maintenance Manual: Spectrum Analyzer TS-723A/U, TS-723B/U, TS-723C/U and TS-723D/U (NSN 6625-00-668-9418) [TO 33A1-13-170-1].
TM 11-6625-261-12	Operator's and Organizational Maintenance Manual: Audio Oscillators TS-382A/U, TS-382B/U, TS-382D/U, TS-382E/U, and TS-382F/U.
TM 11-6625-274-12	Operator's and Organizational Maintenance Manual for Test Sets, Electron Tube TV-7/U, TV-7A/U, and TV-7B/U (NSN 6625-00-376-4939) and TV-7D/U (6625-00-820-0064).
TM 11-6625-291-14	Operator's, Organizational, Direct Support and General Support Maintenance for Output Meters TS-585A/U, TS-585B/U, TS-585C/U (NSN 6625-00-244-0501) and TS-585D/U (6625-00-684-5438) [TO 33A1-7-23-1].
TM 11-6625-320-12	Operator's and Organizational Maintenance Manual: Volt-meter, Meter ME-30A/U and Voltmeters, Electronic ME-30B/U, ME-30C/U and ME-30E/U.
TM 11-6625-366-15	Operator's, Organizational, Direct Support, General Support and Depot Maintenance Manual: Multimeter TS-352B/U (NSN 6625-00-553-0142).

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

WILLIAM J. MEEHAN II
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-51 DS/GS requirements for R-390A/URR.

Change NO. 3

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, 27 *May 1980*

Direct Support, General Support, and Depot Maintenance Manual
RADIO RECEIVER R-390A/URR
(NSN 5820-00-538-7555)

TM 11-5820-358-35, 8 December 1961, is changed as follows:
The title of the manual is changed as shown above.

Page 3. Paragraph 1. Delete subparagraphs c and d.

Paragraphs 1.1, 1.2, 1.3, and 1.4 are added after paragraph 1.

1.1. Indexes of Publications

a. DA Pam 310-4. Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

b. DA Pam 310-7. Refer to DA Pam 310-7 to determine whether there are modification work orders (MWO's) pertaining to the equipment.

1-2. Maintenance Forms, Records and Reports

a. Reports of Maintenance and Unsatisfactory Equipment. Department of the Army forms and procedures used for equipment maintenance will be those prescribed by TM 38-750, The Army Maintenance Management System.

b. Report of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (Packaging Improvement Report) as prescribed in AR 735-11-2/NAVSUPINST 4440.127E/AFR 400-54/MCO 4430.3/E and DSAR 4140.55.

c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/NAVSUPINST 4610.33/AFR 75-18/MCO P4610.19C and DLAR 4500.15.

1.3. Reporting Errors and Recommending Improvements

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms) direct to:
Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-ME-MQ, Fort Monmouth, New Jersey 08803. A reply will be furnished direct to you.

1-4. Reporting Equipment Improvement Recommendations (EIR)

If your Radio Receiver R-390A/URR needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design. Tell us why a procedure is hard to perform. Put it on an SF 368 (Quality Deficiency Report). Mail it to Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-ME-MQ, Fort Monmouth, New Jersey 07703. We'll send you a reply.

Page 161. Paragraph 109j. Delete lines 3 and 6 of the chart.

By Order of the Secretary of the Army:

E. C. MEYER
General, United States Army
Chief of Staff'

Official:

J. C. PENNINGTON
Major General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-51, Direct and General Support maintenance requirements for R-390/URR, R-390A/URR.

Change NO. 2

**HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, 28 *June 1976***

**Direct Support, General Support, and
Depot Maintenance Manual
RADIO RECEIVER R-390A/URR**

TM 11-5820-358-35, 8 December 1961, is changed as follows:
The title is changed as shown above.
Page 52. Paragraph 34 is superseded as follows:

34. Test Equipment for Direct Support Troubleshooting

The following test equipment (or equivalent) and associated technical manuals required for direct support troubleshooting are required.

Test equipment	*Technical manual*
Audio Oscillator TS-382(*)U[a]	TM 11-6625-261-12
Electron Tube Test Set TV-7(*)/U[b]	TM 11-62-274-12
Electronic Multimeter TS.505(*)/U[C]	TM 11-5511
Electronic Voltmeter ME30(*)/D[u]	TM 11-6625320-12
Frequency Meter AN/URM-32(*)[e]	TM 11-5120
Headset HS30-U	
Maintenance Kit MK-288/URM	
Multimeter TS352B/U	TM 11-625366-15
Signal Generator AN/URM-25(*)[f]	TM's 11-4SSB, 11-551D, 11-5551C

[a]Indicates TS382A/U, TS-382B/U, TS-382D/U or TS382EU.
[b]Indicates TV-7/U or TV-7A/U through TV-7D/U.
[c]Indicates TSSO5U or TS-505A/U through TS-505D/U.
[d] Indicates ME-30A/U through ME0C/U or ME-30E/U.
[e]Indicates AN/URM-32 or AN/URM32A.
[f]Indicates ANIURM-25B, AN/URM-25D or AN/URM-25F.

Page 121. Paragraph 87a is superseded as follows:
a. Test Equipment.

Nomenclature	NSN	Technical manual
Audio Oscillator TS-382(*)/U[a]	6625-00-151-7479	TM 11-6625-261-12
Electric Light Assembly MX-1292/PAQ	6695-00-378-5449	TM 11-5540
Electronic Multimeter TS-505(*)/U[b]	6625-00-243-0562	TM's 11-5511, 11-6625-239-12
Electronic Voltmeter ME-30(*)/U[c]	6625-00-643-1670	TM 11-6625-320-12
Oscilloscope OS-8(*)/U[c]	6625 00-643-1740	TM's 11-1214, 11-6625-252-15
Output Meter T68S(*)YUe	6625-00-244-0501	TM 11-5017

Nomenclature	NSN	Technical manual
Signal Generator AN/URM-25(*)[f]	6625-40-649-5193	TM's 11-5551B, 11-5551D, 11-5551E
Spectrum Analyzer TS-723(*)U[g]	6625-00-668-9418	TM 11-6625-255-14

[a]Indicates TS-382A/U, TS-382B/U, TS-382D/U or TS-382E/U.
[b] Indicates TS-505/U or TS-505A/U through TS-505D/U.
[c] Indicates ME-30A/U through ME30C/IU or ME-30E/U.
[d] Indicates OS-8A/U or OS-8C/U.
[e] Indicates TS-585A/U through TS-585D/U.
[f] Indicates AN/URM-25B, AN/URM-25D or AN/URM-25F.
[g] Indicates TS-723B/U or TS-723D/U.

Page 135. Paragraph 93c. Make the following changes in the "'Test equipment control settings" column:
Step No. 1, line 17. "(Carrier control: max)" is changed to read "(Carrier control: max ccw)." Step No. 2, line 6. "switch: 3.0-915 MC)" is changed to read "switch: 3.0-9.5 MC)." Make the following changes in the "Equipment under test control settings: column:
Step No. 1, line 8. "BFO: ON" is changed to read "BFO: OFF." Line 9. "BANDWIDTH: 16" is changed to read "BANDWIDTH: 8." Make the following changes in the "Test procedure" column:
Step No. 1*d*, line 2. "control) control clockwise until AN/URM-25F" is changed to read "control) control until AN/URM-25F." Subparagraph f is superseded as follows:

f. Turn the AN/URM-25F MICROVOLTS control max ccw.

Step No. 7. Subparagraphs a through f are superseded as follows:

*a***.** Turn the AN/URM-25F SET RF OUTPUT (carrier control) control until AN/URM-25F meter indicates full scale (10). Turn AN/URM-25F FUNCTION SWITCH to 400 and adjust %MOD AUDIO OUT LEVEL control for indication of 30 on %MOD scale of AN/URM-25F meter. Adjust AN/URM-25F main tuning dial for peak TS585(*)/U indication.

b. Adjust receiver ANT TRIM control for peak indication on TS-585(*)/U.

c. Turn AN/URM-25F FUNCTION SWITCH to CW and receiver BFO switch to ON. Adjust receiver BFO PITCH control for approximately 1 kHz audio output from the receiver.

d. Turn receiver BFO switch to OFF and 2 AN/URM-25F MICROVOLTS control maximum CCW.

e. Set TS-585(*)/U meter multiplier switch to 1 and adjust receiver LOCAL GAIN control for a 1-milliwatt indication on TS-585(*)/U meter. Adjust AN/URM-25F MICROVOLTS control for a 10-milliwatt indication on the TS-585(*)/U. Readjust the receiver LOCAL GAIN control for a 1-milliwatt indication on the TS-585(*)/U.

f. Turn receiver BFO switch to ON and readjust the AN/URM-25F MICROVOLTS control until TS-585(*)/U meter indicates 10 milliwatts. Note and record AN/URM-25F meter indication (MIC ROVOLTS scale).

Page 159. Paragraph 105a is superseded as follows:

a. Test Equipment. The following test equipment (or equivalent) is required for depot testing of Radio Receiver R-390A/URR.

Test equipment	NSN	Quantity
Electronic Multimeter TS-505/U	6625-00-243-0562	1
Radio Test Set AN/URM-26A	6625-00-543-1356	1
Signal Generator AN/URM-25D	6625-00-649-5193	1
Signal Generator AN/USM-44A	6625-40-539-9685	1
Spectrum Analyzer TS-723D/U	6625-00-668-9418	1
Voltmeter, Meter ME-30(*)/U	6625-00-643-1670	1

Page 161. Paragraph 110g is superseded as follows:

g. The signal generator attenuator setting must not be greater than 4 microvolts to produce the 7-volt indication in f above.

Page 162. Paragraph 113. Make the following changes:
Subparagraph *c*, line 2. "*b*" is added after "in."
Subparagraph *f*, line 4. "20 $\pm$6." is changed to read "20 $\pm$10db".

By Order of the Secretary of the Army:

FRED C. WEYAND
General, United States Army
Chief of Staff

Official:

VERNE L. BOWERS
Major General, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-51, (qty rqr block no. 903) Direct General Support requirements for R-390A/URR.

Changes In force: C 1

TM 11-5820-358-35
C1

CHANGE

No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, *3 April 1975*

Field and Depot Maintenance Manual
RADIO RECEIVER R-390A/URR

TM 11-5820-358-35,8 December 1961, is changed as follows:
Inside front cover. Radiation warning is superseded as follows:

WARNING
RADIATION HAZARD

RADIOACTIVE MATERIAL
CONTROLLED DISPOSAL REPAIRED
ACCOUNTABILITY NOT REQUIRED
STD RW--2

Audio level meter	Ra 226	0.69uCi	6625-00-669-0769
Audio level meter	Ra 226	0.40uCi	6625-00-669-0769
	Electron Tube	OA2WA	5960-00-503-4880
EEVC	U 238	0.1uCi	
CBS Hytron	Ni 63	0.5uCi	
Raytheon	Co 60	0.2uCi	

Radiation Hazard Information: The following radiation hazard information must be read and understood by all personnel before operating or repairing the Radio Receiver R-390AURR. Hazardous radioactive materials are present in the above listed components of R-390A/URR

The components are potentially hazardous when broken. See qualified medical personnel and the local Radiological Protection Officer (RPO) immediately if you are exposed to or cut by broken components

First aid instructions are contained in TB 43-0116, TB 43-0122 and AR 7'51& NEVER place radioactive components in your pocket.

Use extreme care NOT to break radioactive components while handling them.

NEVER remove radioactive components from cartons until you are ready to use them.

If any of these components are broken, notify the local RPO immediately. The RPO will survey the immediate area for radiological contamination and will supervise the removal of broken components.

The above listed radioactive components will not be repaired or disassembled

Disposal of broken, unserviceable, or unwanted radioactive components will be accomplished in accordance with the instructions in AR 7561.

By Order of the Secretary of the Army:

FRED C. WEYAND
General, United States Army
Chief of Staff

Official:

PAUL T. SMITH
Major General, United States Army
The Adjutant General

Distribution:
To be distributed in accordance with DA Form 12-51, Direct and General Support maintenance requirements for R390A/URR.

Technical Manual
No. 11-5820-358-35

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, *8 December 1961*

RADIO RECEIVER R-39OA/URR

*This manual together with TM 11-5820-358-10, 16 January 1961, and TM 11-5820-358-20, 10 February 1961, supersedes TM 11--856A, 20 January 1956; including C1, 19 March 1956; C2, 17 May 19 56; C3, 23 November 1956; C4, 7 June 1957; C5, 23 July 1958; and C6, 13 November 1958.

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CHAPTER 1
THEORY

Section I. INTRODUCTION

1. Scope

a. This manual covers field and depot maintenance for Radio Receiver R-390A/ URR. It includes instructions appropriate to third, fourth, and fifth echelons for troubleshooting, testing, aligning, and repairing the receiver and replacing maintenance parts. It also lists tools, materials, and test equipment for third, fourth, and fifth echelon maintenance. Detailed functions of the equipment are covered in the theory section.

b. The complete technical manual for this equipment includes four other publications: TM 11-5820-358-10, TM 11-5820358-20, TM 11-5820-358-20P, and TM115820-358-35P.

c. Forward comments concerning this manual to the Commanding Officer, U. S.
Army Signal Materiel Support Agency, ATTN: SIGMS-PA2d, Fort Monmouth, N.J.
Note: For applicable forms and records, see paragraph 2, TM 11-5820-358-10.

d. Refer to DA Pamphlet 310-4 to determine what changes to or revisions of this publication are current.

2. Internal Differences in Models

During production of the receiver, several changes were made in the equipment.
Each of these changes is shown on the receiver by means of a modification (MOD) number stamped on the affected subchassis. These MOD numbers are used in this manual to indicate equipment revisions.

a. Use of MOD Numbers. Equipment modifications listed in c (below) show the modified subchassis or part and the MOD number used on various order numbers.
A MOD number higher than 1 indicates that all earlier modifications have also been performed.

b. MOD Numbers on Parts. Some receivers may have a MOD number stamped on a part rather than on a subchassis. For example, a MOD number is stamped on the shielding cans of tuned-circuit assemblies Z201-1 and Z201-2 in some receivers. This indicates that a modification has been made to the part; it is not a subchassis modification.

c. Equipment Modification Chart.

Modifications	Subchassis or part bearing MOD No.	MOD numbers	
		Orders No. 14214-Phila-51, 375-Phila-54, and 08719-Phila-55	Order No. 363-Phila-54
Pin 7, V201, connected to ground instead of to pin 2.	RF	2	1
C275 changed from 5,000 uuf to	Rf	2	1
3,300uuf.	RF	1	1
C612, 68 uuf, added in parallel with	Af	4	2
R601.	Rf	3	2
C257, 47 uuf, added in parallel with C227.			
Series network of C256, 0.1 uf, and R235,			
47 ohms, inserted between terminal 1 of HR202 and ground.			
C232-1 and C232-2 changed from 2,400 uuf to 1,500 uuf.	Z201-1, Z201-2	1	3
Suppressor E213 added between contact	Rf	5	2
9 of S204 front and junction of E208, R233, and C255.			
C507 and C516 changed from selected value to 51 uuf.	If.		1

Modifications	Subchassis or part bearing MOD No.	MOD numbers	
		Orders No. 14214-Phila-51, 375-Phila-54, and 08719-Phila-55	Order No. 363-Phila-54
C508 through C510 and C513 through C515 changed from selected values to 82 uuf (para 64).	IF.		1
Trimmer capacitors C564 through C571 added (fig. 15) (e below).	IF.	2	1
R504 changed from 1,000 to 560 ohms	IF.	2	1
If. transformers T502 through T503 stagger-tuned at factory[a]	IF.		1
B+ fuses (f below).			

[a]This was also done to receivers on Order No. 08719-Phila-55 with serial numbers 00 and higher.

d. Modifications to Receivers Bearing Order No. 14-Phila-56. All of the modifications listed in c above were made to receivers bearing Order No. 14-Phila-56; however, MOD numbers were stamped only on tuned-circuit assemblies Z201-1 and Z201-2. For identification, the order number has been stamped on each subchassis.

e. Alternate- Type Filters in Some Receivers Bearing Order No. 14-Phila- 56. Some receivers bearing Order No. 14Phila-56 have 8- and 16-kilocycle (kc) mechanical filters, FL504 and FL505 (fig. 38), that require a decreased amount of tuning capacitance across their inputs and outputs. In these receivers, capacitors C515 (82 micromicrofarad (uuf)) and C516 (51 uuf) (fig. 38) are not connected to the output terminals of the filters; instead, both capacitor leads are attached to ground lugs on the filter mounting screws. In addition, capacitors C507 (51 uuf) and C508 (8 uuf) are not connected to the input terminals of the filters; instead, both capacitor leads are attached to ground lugs on a shield underneath the intermediate frequency (if.) chassis. These capacitors are available when filters requiring the full amount of tuning capacitance are installed in the receiver. Capacitors C564, C565, C570, and C571 remain in the circuits.

f. B+ Fuses. Receivers bearing Order No. 14-Phila-56, serial numbers 2683 and above, and Order No. 14385-Phila-58 have two additional fuses (fig. 87) for B+ circuit protection. Fuse F102 is located in the B+ line between pin 5 of plug P111 and pin 5 of plug P119. Fuse F103 is located in the B+ line leading from pin 2 of plug P119.

Section II. SIMPLIFIED THEORY OF RECEIVER

3. General

a. Radio Receiver R-390A/URR provides reception of continuous wave (cw), modulated continuous-wave (mew), and amplitude-modulation (am.) (including single-sideband (ssb)) signals over a continuous frequency range of 0.5 to 32 megacycles (mc). The receiver is a super, heterodyne type with multiple frequency conversion. Double conversion is used when the receiver operates from 8 to 32 me and triple conversion from 0.5 to 8 mc.

b. Linear tuning allows constant frequency spread throughout the range. Tuning is accomplished by the movement of powdered-iron cores in the radio frequency (rf) and variable intermediate frequency coils at a rate controlled by a mechanical arrangement of gears, shafts, and cams.

4. Block Diagram of Receiver

(fig. 85)

a. Rf signals are fed into the receiver either by a balanced two-wire antenna such as a doublet: or by an unbalanced antenna such as a whip or random-length wire antenna. Antenna relay K101 disconnects and grounds the antenna during standby, calibration or break-in operation. When K101 is not energized, the balanced antenna is connected to the input of one of the antenna transformers, T201 through T206, which is selected by the MEGACYCLE CHANGE control. The transformers are tuned by the kilocycle CHANGE and/or the MEGACYCLE CHANGE tuning controls. The output of the antenna transformers is fed into rf amplifier V201. The signal from the unbalanced antenna is fed directly to rf amplifier V201.

b. The calibration circuit, consisting of calibration oscillator V205A, 100-kc multivibrator V206, and 100-kc cathode follower V205B, injects 100-kc markers into the input circuit of rf amplifier V201. When the FUNCTION switch is in the CAL position, B+ is connected to the calibration circuit.

c. Rf amplifier V201 amplifies the signals from the antenna before they are fed to first mixer V202. One of the six tuned rf circuits, depending on frequency, is selected by the MEGACYCLE CHANGE control. The tuned rf circuits are adjusted by the KILOCYCLE CHANGE and/or the MEGACYCLE CHANGE controls.

d. Received signals from 0.5 to 8 mc are coupled from rf amplifier V201 and fed into the input circuit of first mixer V202. The 8- to 32-mc signals from V201 are switched around the first mixer and fed directly into second mixer V203. When the receiver is operated between 0.5 and 8 mc, the first mixer mixes the rf signals with a 17-mc signal from first crystal oscillator V207. The output (sum) frequency is the first variable if. signal; its frequency varies from 17.5 to 25 mc. Tuned circuit Z213 is a triple,-tuned device that is tuned as the MEGACYCLE CHANGE and the KILOCYCLE CHANGE controls are operated.

e. The output frequency of second crystal oscillator V401 is fed into second mixer V203. As the MEGACYCLE CHANGE control is operated, it changes the output frequency of V401 so that the frequency difference between the output of V401 and the received signal is always between 3 and 2 mc. This is the second variable if. signal. When the receiver is tuned between 0.5 and 0.999 mc, V401 feeds a 21-mc signal into V203. When the receiver is tuned between 1 and 1.999 mc, V401 feeds a21-mc signal into V203. The output frequency of V203 varies downward from 3 to 2 mc, except on the 0.5- to 1-mc band, where the output frequency of V203 varies between 2.5 and 2 mc. A set of coils Z216, tunes the output of V203 as the KILOCYCLE CHANGE control is operated.

f. The 3- to 2-mc output of the second mixer is fed through Z216 to third mixer V204 where it is mixed with a continuously variable signal (3.455 to 2.455 mc) from variable-frequency oscillator V701. This precision oscillator is tuned by the KILOCYCLE CHANGE control. The output of V204 is fed to tuned circuit T208 and is a fixed frequency of 455 kc. This is the third if. signal.

g. The 455-kc third if. signal is fed into or around 455-kc crystal filter Y501, as determined by the setting of the BANDWIDTH control. When this control is turned to .1 or 1, the 455-kc signal is fed through crystal filter Y501. In all other positions, the 455-kc signal is bypassed around the crystal filter and applied to first if. amplifier V501. The output of V501 is fed into one of four mechanical filters (FL502 through FL505) selected by the BANDWIDTH switch. The output from the selected filter is fed successively through the second, third, and fourth if. amplifiers (V502, V503, and V504, respectively).

h. The output of fourth if. amplifier V504 is fed into detector V506B. The audiofrequency (af) output from V506B is fed to limiter V507.

i. Beat-frequency oscillator (bfo) V505 generates and feeds variable-frequency signals (452 to 458 kc) to detector V506B. The resultant beat frequency is adjustable continuously from 0 to 3,000 cycles per second (cps). Setting the BFO switch to the ON position applies B+ to the bfo.

j. The audio output from limiter V507 is fed to first af amplifier V601A. This stage amplifies the audio signal and passes it through or around 800-cps bandpass filter FL601, depending on the setting of the AUDIO RESPONSE switch. The audio signal is then fed to af cathode follower V601B. This stage feeds the audio signals to the local and line audio channels. The local audio channel consists of local af amplifier .V602A and local af output tube V603. This audio source is used for 600-ohm headsets and loudspeakers. The line audio channel is similar to the local audio channel, consisting of line af amplifier V602B and line af output tube V604B. This output matches a balanced 600-ohm line.

k. The if. signals (455 kc) at the input to fourth if. amplifier V504 are also fed to if. cathode follower V509B. This stage provides a 50-ohm source of 455kc signals for use with a frequency shift converter for teletypewriter operation. Tube V509B also feeds 455-kc signals to automatic gain control (agc) if. amplifier V508. This stage amplifies the 455-kc signal and feeds it to agc rectifier V509A. The rectified output is proportional to the average amplitude of the if. signal. This age bias is fed to the control grid circuits of V201 through V204 and V51 through V503. Age time-constant tube V506A provides agc time constants of various durations when the AGC switch is set to its various positions.

l. The B+ supply for the receiver is powered by a source of 115 or 230 volts alternating current (ac) at 48 to 62 cps. The ac power is rectified by V801 and V802. A direct-current (dc) source regulated at 150 volts is provided by voltage regulator V605. This voltage is supplied to the screen grids of V207, V401, and V701.

m. When proper connections are made to the BRK IN terminal of TB103 (TM 115820-358-20), and the BREAK-IN switch is at ON, a radio transmitter can be used in break-in operation with the receiver. Break-in relay K601 disconnects and grounds the antenna, and it also grounds the audio signal in the receiver.

Section III. STAGE ANALYSIS

5. General

Radio Receiver R-390A/URR consists of a main frame and six subchassis. These are the rf subchassis, variable-frequency oscillator (vfo) subchassis, crystal-oscillator subchassis, if. subchassis, af subchassis, and the power-supply subchassis.

6. Antenna Circuit

(fig. 1 and 2)

The antenna circuit matches antennas of various characteristics to rf amplifier V201.

a. The BALANCED ANTENNA connector, J104, has a characteristic impedance of 125 ohms. Two-wire antenna systems, such as doublets with either 50ohm twisted pair or coaxial transmission lines or with 50- 200-ohm twin-lead transmissions lines, may be used without serious mismatch. Long wire antennas may also be used if one side of J104 is connected to ground. The UNBALANCED ANTENNA connector, J103, is used for whip, long-wire, random-length, and single-wire antennas.

b. Antenna relay K101 grounds the unbalanced or balanced antenna inputs from J104 or J103 and opens the antenna coil circuits during standby, calibration, or break-in operation. Relay K1O1A opens the antenna coil primary circuits through switches S201 and S202. Relay K101B opens the antenna coil secondary circuits through switch S205, for single-wire antenna systems. Resistor R121 drains static charges that may accumulate on a single-wire antenna during mobile operation. Neon lamp 1103 fires and shorts R121 whenever the rf potential at J103 exceeds 80 to 90 volts.

c. Figure 2 shows rf band switches S201 through S205 in the 0.5- to 1-mc positions. This corresponds to frequency indicator setting of 00. The two-wire antenna signals are fed through S201 and S202 to the coil corresponding to the frequency indicator setting. The two-wire antenna is balanced across primary L212 of antenna transformer T201 by series-connected capacitors C201A and C202. Capacitor C201A permits adjustment of the balance. When a

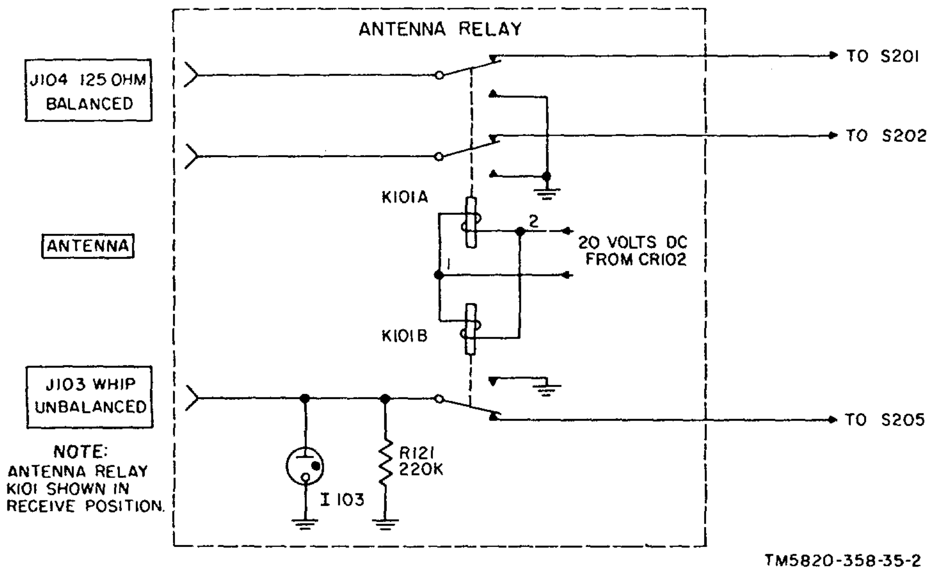


Figure 1. Antenna relay circuit, simplified schematic diagram.

single-wire antenna is used, connection is made to the appropriate coil through S205. Capacitor coupling through C204 provides good signal transfer between the antenna and coil for a wide variety of antennas.

d. Capacitor C201B is used during alignment. ANT TRIM capacitor C225 is used o obtain maximum signal transfer from the antenna to the input of the receiver. Capacitor C203 is also connected across L213 in parallel with C201B and C225. This provides the additional capacitance necessary to tune L213 to resonance at the correct frequency. The individual sections of C225 are switched by S203 front and rear (fig. 2) from parallel to series or out of the circuit, depending on the frequency to which the receiver is tuned. The chart in paragraph 30e lists the details of the switching scheme.

e. The rotor of the rear section of switch S204 shorts adjacent secondary winding T203; this prevents transformer interaction. Paragraph 30d lists the short-circuit switching scheme. The front section of S204 selects the proper antenna transformer and connects it to V201 through R233 and C255. Resistor R233 and capacitor C255 add to the negative bias from the age line at the control grid of V201 when extremely strong signals cause grid current to flow. Test point E208 is used for test and alignment purposes. Resistors R201 and R234 in combination with capacitor C226 form a time-constant circuit feeding age voltage to the control grid of V201. Parasitic suppressor E213 was added in some models (para 2c).

7. Rf Amplifier V201
(fig. 2 and 3)

The antenna signals are amplified by V201. The rf amplifier also prevents radiation by the antenna of the various signals generated by the oscillators in the receiver.

a. When the FUNCTION switch is on AGC, the grid circuit is returned to ground through the antenna coils and age line. When the FUNCTION switch is on MGC (fig. 89), the grid circuit is returned directly to ground. The antenna signals from the front section of switch S204 are fed through the grid-leak network of R233 and C255 to the control grid of V202. The 1-uuf capacitor C228 couples 100-kc marker signals into the grid circuit when the FUNCTION switch is on CAL. Suppressor E213 was added on certain models (para 2) to eliminate parasitic oscillations.

b. Cathode bias is provided by resistor

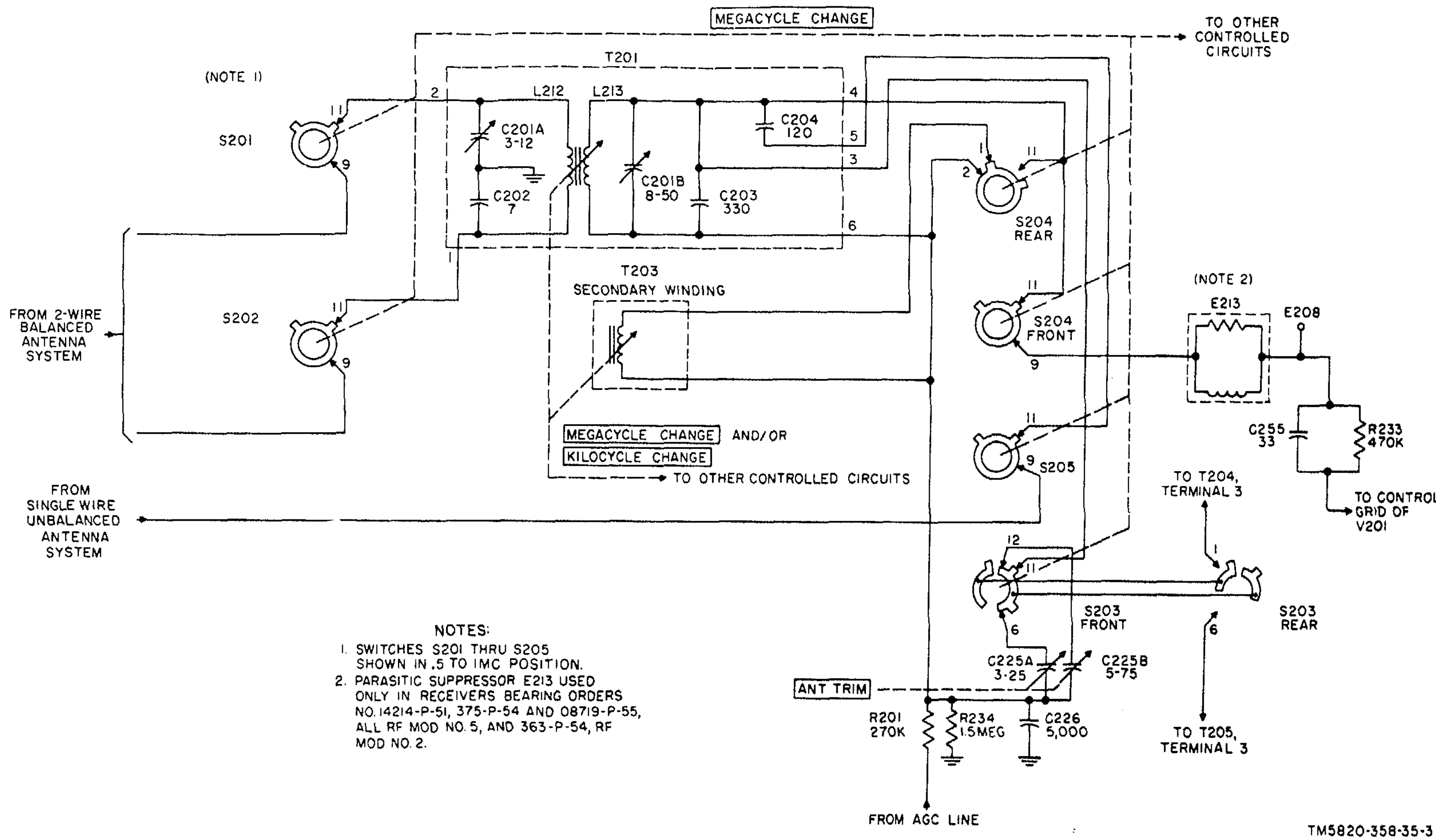


Figure 2. RF band switches S201 through S205, simplified schematic diagram.

R202 and RF GAIN control R103. This control adjusts the cathode bias and, consequently, the gain of rf amplifier V201. RF GAIN control R103, bypassed by C103, is tied into the cathode circuit by the RF GAIN jumper on terminals 1 and 2 of TB102. This jumper (TM 11-5820-358-10) can be removed and a remote rf gain control can be used. Capacitor C227 bypasses the cathode to ground to prevent cathode circuit degeneration. Capacitor C257 is added in parallel with capacitor C227 on some models (para 2) for effective rf bypassing.

c. Plate and screen grid voltage is obtained from the switched rf-if. B+ line through rf choke L209 bypassed by C308. Voltage for the screen grid is applied from the junction of voltage divider resistors R204 and R203. Capacitor C229 keeps the screen grid at rf ground potential. Plate voltage for V201 is fed through the decoupling network of R205 and C248, tuned circuit L224-1 of Z201-1 (for frequencies between 0.5 and 1 mc), contacts 11 and 9 of S206, and parasitic oscillation suppressor E212.

d. Switch section S206 of the rf band switch selects one of six tuned circuits, Z201-1 through Z201-6 (fig. 3 and89). The coils are permeability tuned by ferrite slugs inserted into the coils by the KILOCYCLE CHANGE and/or the MEGACYCLE CHANGE controls. The variable and fixed capacitors in Z201-1 and Z201-2 resonate with the coils and tune the plate circuit of V201 and the control grid circuit of V202 over the 0.5- to 1-megacycle range. Capacitor C254 couples the signal from Z201-1 to Z201-2. Tuned circuit Z201-2 is similar to Z201-1 except that capacitor C276 is connected across L224-2 (externally) to compensate for the plate capacitance of V201. The control grid circuit of first mixer V202 is connected at the junction of series-connected capacitor C231-2 and C232-2, to minimize the loading of Z201-2 by first mixer V202. The desired tuned circuit (Z201-2 through Z206-2) is selected by MEGACYCLE CHANGE switch section S207, and the signal is fed through parasitic oscillation suppressor resistor R208 to the first mixer control grid (V202). Test point E209 is used for testing and alignment.

8. First Mixer V202 (fig. 4)

First mixer V202 mixes the 0.5- to 8mc signals from rf amplifier V201 with a 17-mc signal from first crystaloscillator V207. This develops the first variable if.; its range is from 17.5 to 25 mc.

a. The grid circuit of V202 is returned to ground through grid resistor R231, the decoupling network of R232 and capacitors C273 and C284, and rf choke L208, and then through the agc circuit when the FUNCTION switch is on AGC, and to ground when the FUNCTION switch is on MGC. Resistor R208 is a parasitic oscillation suppressor. Test point E209 is provided for testing and alignment. Cathode bias for V202 is developed by R209 and C277. The 17-mc signal from V207 is injected into the mixer stage through L231. Plate voltage for V202 is fed from the switched rfif. B+ line through rf choke coil L209 bypassed by C308, the decoupling network of R212 and C280, and L232-1 of Z213-1.

b. The cathode of V202 receives a fixed 17-mc signal, while the control grid receives signals within the range of 0.5 to 8 me. The plate circuit is tuned to the sum of these two inputs (17.5 to 25 mc). Tuned circuits Z213-1, Z213-2, and Z213-3, together with coupling capacitors C281 and C282, form a triple-tuned circuit. Trimmer capacitors C283-1, C283-2, and C283-3, coils L232-1, L232-2, and L232-3, and fixed capacitors C318, C329, and C334 across their respective coil assemblies form the tuned circuits.

c. The rear section of switch S208 shorts the output of tuned circuits Z213-3 to ground and opens the +150-volt regulated power source to the first crystal-oscillator screen grid when the receiver is tuned above 8 me. The front section of switch S208 feeds the 17.5- to 25-mc signal from Z213-3 to V203 through coupling capacitor C226 and parasitic oscillation suppressor R214 when the receiver is tuned to between 0.5 and 8 mc. Test point E210 is provided for testing and alignment.

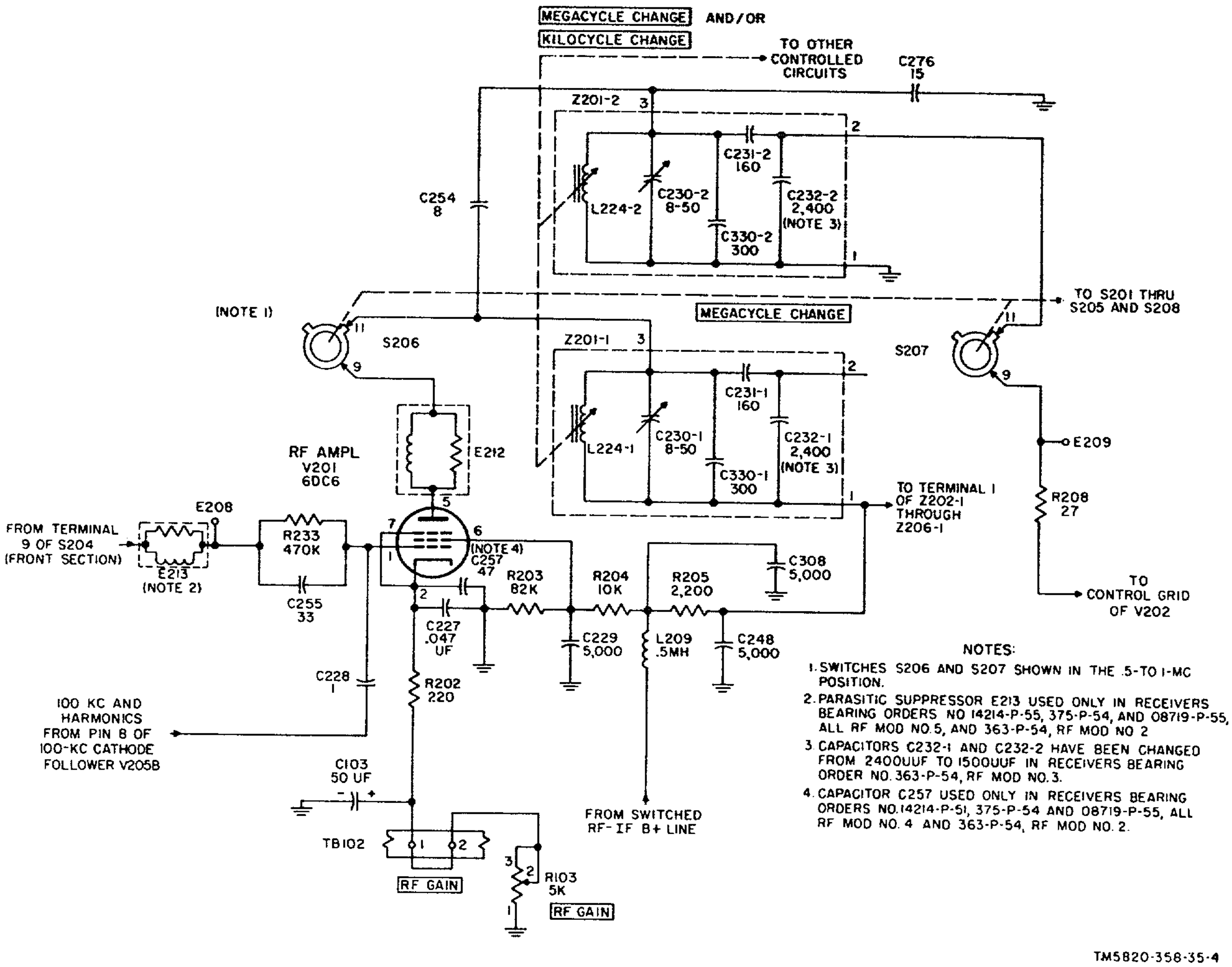


Figure 3. Rf amplifier V201, simplified schematic diagram.

9. First Crystal Oscillator V207

(fig. 4 and 5)

First crystal oscillator V207 generates a 17-mc crystal-controlled signal for cathode injection into first mixer V202. This stage is operative only between 0.5 and 8 mc.

a. Crystal Y201 is contained in crystal oven HR202 and maintained at a temperature between 72° and 78° C. Resistor R207 is the grid resistor. Capacitors C324 and C325 form an approximately 10-to-i feedback voltage divider for maintaining oscillation. Coil L201 provides a large impedance at 17 me while maintaining the cathode of V207 at dc ground potential.

b. Plate voltage is supplied from the rf-if. B+ line through the decoupling network of R211 and C328, and L230 of T207. The plate load consists of L230 and C327, resonant to 17 me. The screen grid voltage for V207 is applied through switch contacts 7 and 6 of S208 rear and voltage-dropping resistor R210. Capacitor C326 keeps the screen grid at rf ground potential. Switch S208 rear removes the screen grid voltage from V207 when the receiver is tuned above 8 me. Capacitor C275 keeps the +150-volt regulated dc line at rf ground potential.

c. The 17-mc signal is developed across coil L231 (secondary winding of T207). This coil is in the dc cathode path for first mixer V202, and feeds the 17-mc signal to the cathode of V202.

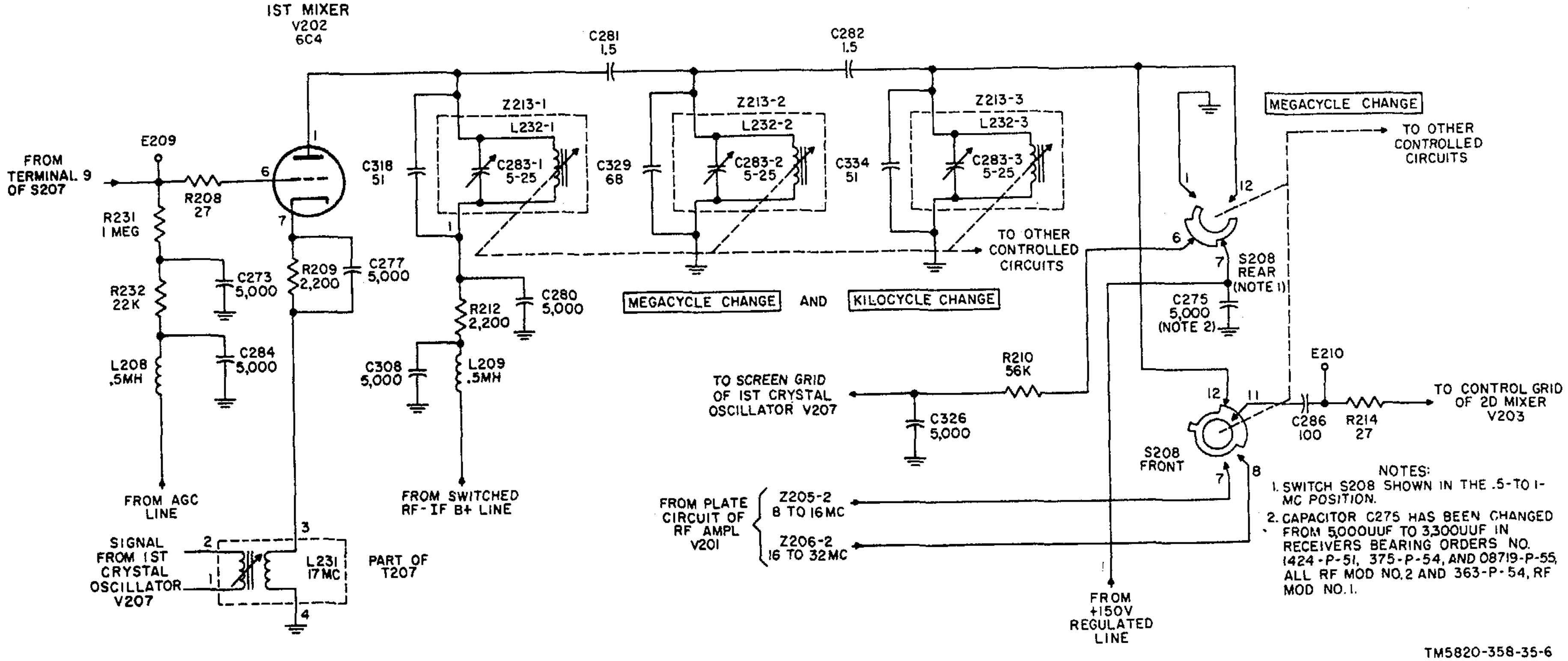


Figure 4. First mixer V202, simplified schematic diagram.

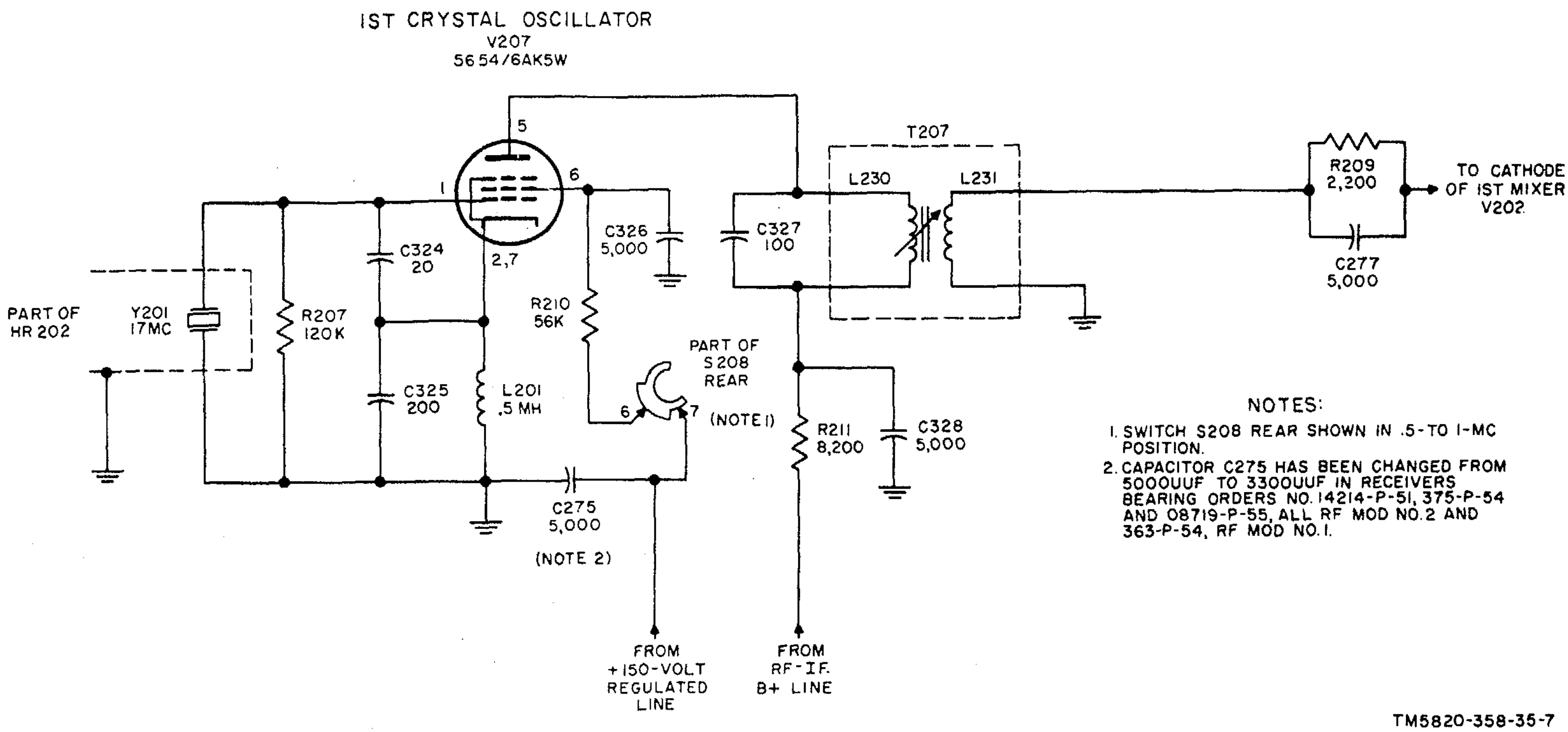


Figure 5. First crystal oscillator V207, simplified schematic diagram.

10. Second Mixer V203

(fig. 6)

Second mixer V203 receives 17.5- to 25-mc signals on the control grid from first mixer V202 when the receiver is tuned from 0.5 to 8 me, and 8- to 32-mc signals from rf amplifier V201 when the receiver is tuned from 8 to 32 mc.

a. Signals are coupled to the grid of V203 through C286 and parasitic oscillation suppressor R214. The grid circuit is returned to ground through resistor R214, grid resistor R213, the decoupling network that consists of R206 and C319, and the agc circuit. Agc bias is fed to the control grid when the FUNCTION switch is on the AGC position, and the agc line is grounded when the FUNCTION switch is set to MGC. Cathode bias is provided by R215 and C287. Transformer T401 couples one of 32 frequencies into the cathode of V203. Plate voltage for second mixer V203 is obtained from the switched rf-if. B+ line, through rf choke coil L209, the plate decoupling network of C308, R216, and C288, and coil L233-1. Test point E210 is provided for testing and alignment.

b. Triple-tuned circuits Z216-1, Z2162, and Z216-3 are tuned by the KILOCYCLE CHANGE control to the difference between the incoming control grid and cathode signals. These three tuned circuits are coupled by C289 and C290. Variable capacitors C291-1, C291-2, and C291-3 are used for alignment purposes. Test point E211 is used for testing and alignment, and R230 is a parasitic oscillation suppressor. The injection signal from V401 and the signal on second mixer grid V203 produce a difference frequency between 3 and 2 mc. This differences frequency is the second variable if. Agc bias is fed to the control grid of third mixer V304 through the agc filter network consisting of R217 and C297, L233-3, and parasitic oscillation suppressor R230 to the control grid of third mixer V304.

11. Second Crystal Oscillator V401

(fig. 7)

Second crystal oscillator V401 is a modified Colpitts oscillator that generates and feeds one of 32 frequencies to second mixer V203. The MEGACYCLE CHANGE control drives two 32-contact switches. These switches select certain crystals and resonant plate circuits for the oscillator. The plate circuit of V401 is tuned to the fundamental, second, or third harmonic of the crystal selected. The exact frequencies and the switching scheme are shown in figure 8. A total of 15 crystals is used to produce 32 frequency selections.

a. Each crystal, Y401 through Y415, is switched between the control grid of V401 and ground by MEGACYCLE CHANGE switch S401. Grid resistor R404 and series capacitors C408 and C409 form an approximately 10-to-1 voltage divider across the grid circuit. The cathode is connected at the junction of these two capacitors, and is maintained above rf ground by rf choke coil L401. The screen grid of V401 is held at rf ground potential by feedback capacitor C410. Test point E402 provides a convenient test point for checking the grid voltage of the oscillator stage.

b. Plate voltage is supplied from the rf-if. B+ line through the decoupling network consisting of C413, R407, C412, R406, and C411, and L403 of T401. Screen grid voltage is applied through the decoupling network consisting of C401, R405, and C410.

c. The output of the oscillator is inductively coupled to L404. This coil is in the cathode circuit of second mixer V203 and feeds the oscillator signal to the cathode of V203.

12. Third Mixer V204

(fig. 9)

Third mixer V204 heterodynes the 3to 2-mc output signals from second mixer V203 with the output of variable frequency oscillator V701. .The frequency range of V701 is 3.455 to 2.455 mc. The resultant fixed third intermediate frequency of 455 kc is the difference between the two input signals.

a. The 3.2 mc signal from mixer V203 is coupled through parasitic oscillation suppressor R230 to the control grid of V204. The cathode of V204 is fed with

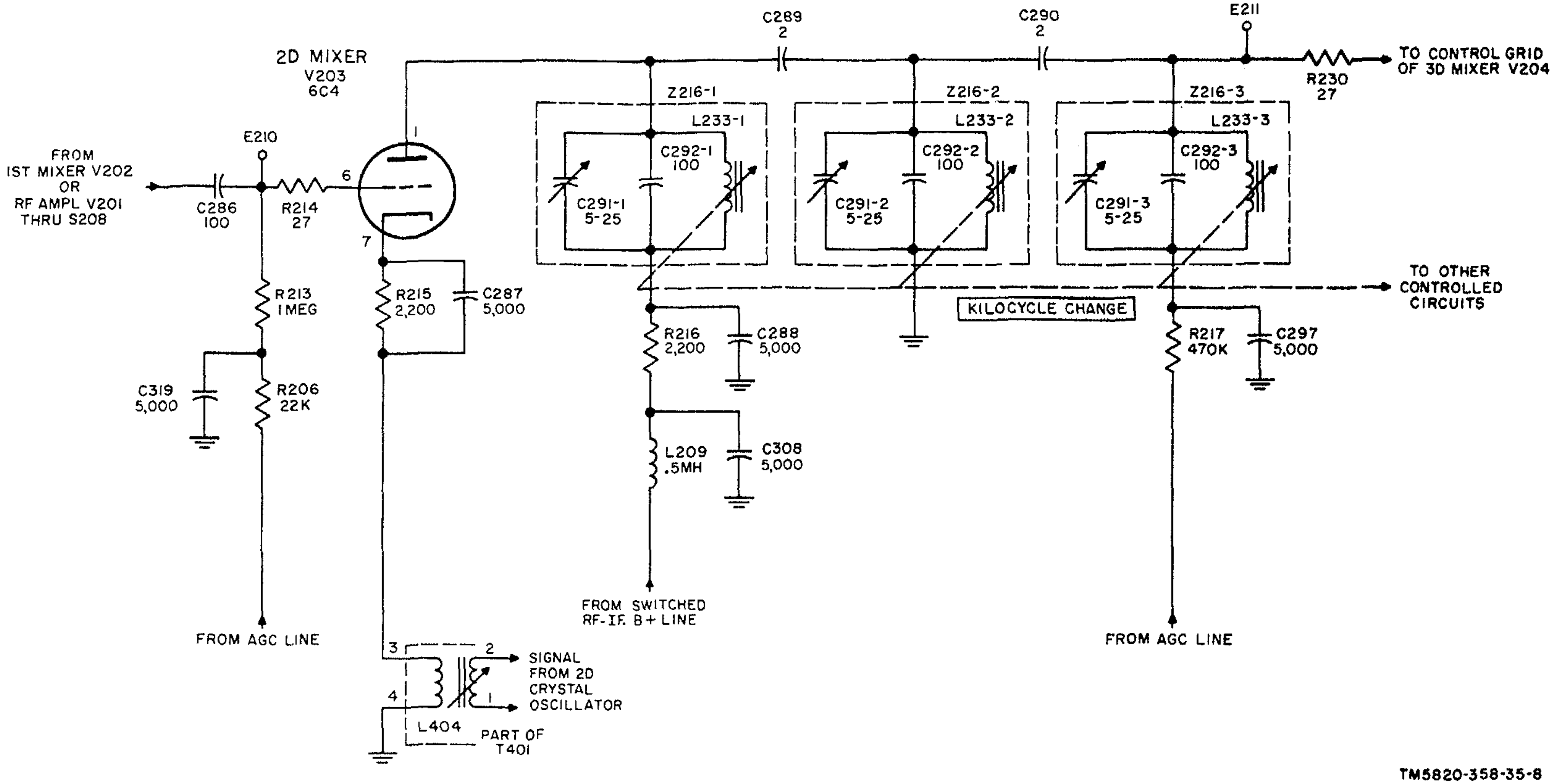


Figure 6. Second mixer V203, simplified schematic diagram.

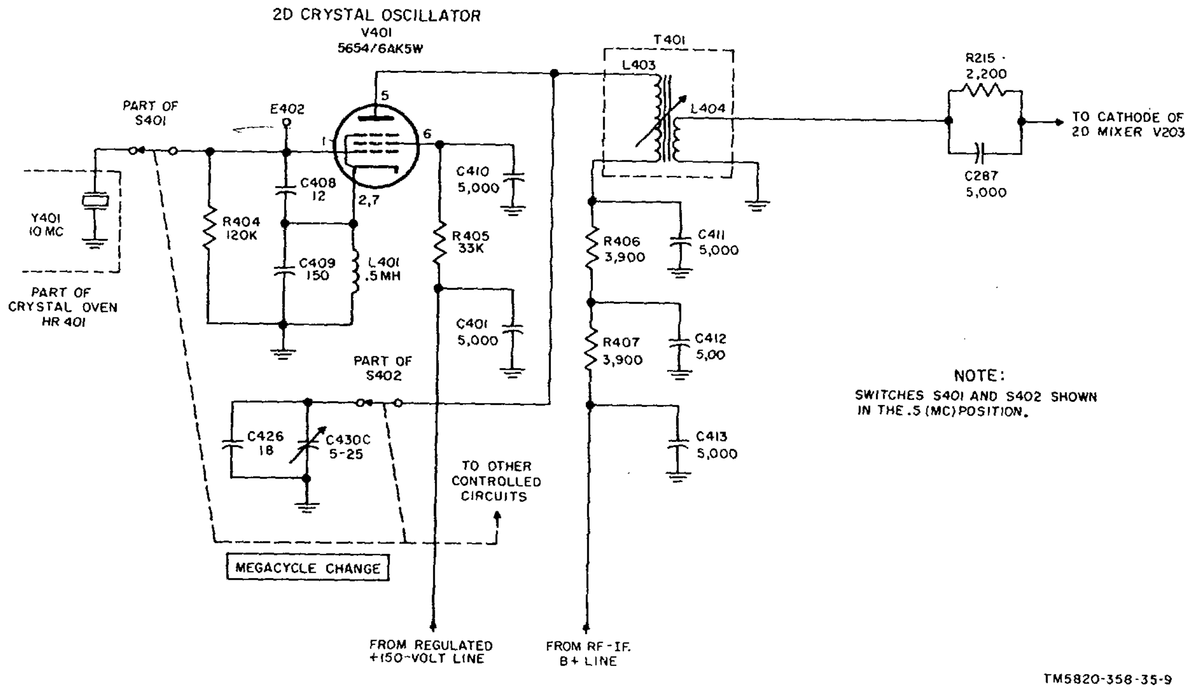


Figure 7. Second crystal oscillator V401, simplified schematic diagram.

variable-frequency oscillator signal s from V701 through the secondary winding of T701. Cathode bias is provided by R218 and C298. Plate voltage for the circuit is furnished from the switched rf-if. B+ line through rf filter choke L209, the voltage-dropping and decoupling network consisting of C308, R219, and C307 and the primary of T208.

b. As the receiver input frequency increases, the second variable intermediate frequency fed to the grid of V204 decreases, and the vfo signal fed to the cathode likewise decreases. The rate of change of these two signal sources is such that the plate circuit at all times is tuned to a constant difference frequency of 455 kc. Coil L234 is tuned to approximately 455 kc by fixed capacitor C299. Adjustment to exactly 455 kc is made with the powdered-iron slug in the coil. Secondary coil L235, of T208, is center-tapped. The signals across the two halves are 180° out of phase with each other and are fed to the input circuit of first if. amplifier stage V501.

13. Variable-Frequency Oscillator V701

(fig. 10)

Variable-frequency oscillator V701 generates the signals fed to the cathode circuit of third mixer V204. The frequency range of V701 is precisely 3.455 to 2.455 me. The frequency-determining elements of this circuit are contained in oven HR701, which operates when the OVENS switch on the rear panel is in the ON position (fig. 90).

a. The variable-frequency oscillator is an electron-coupled Hartley oscillator. The screen grid acts as the plate of an equivalent triode oscillator circuit. A powdered-iron slug in coil L702 is moved in the coil by the operation of the KILOCYCLE CHANGE control. Coils L701 and L702 with capacitors C701, C702, and C703 form the frequency-determining circuit. Capacitor C704 and resistor R701 develop grid-leak bias on the control grid of this tube.

b. Screen grid voltage for V701 is obtained from the +150-volt regulated line and is fed through the voltage-dropping and decoupling network consisting of

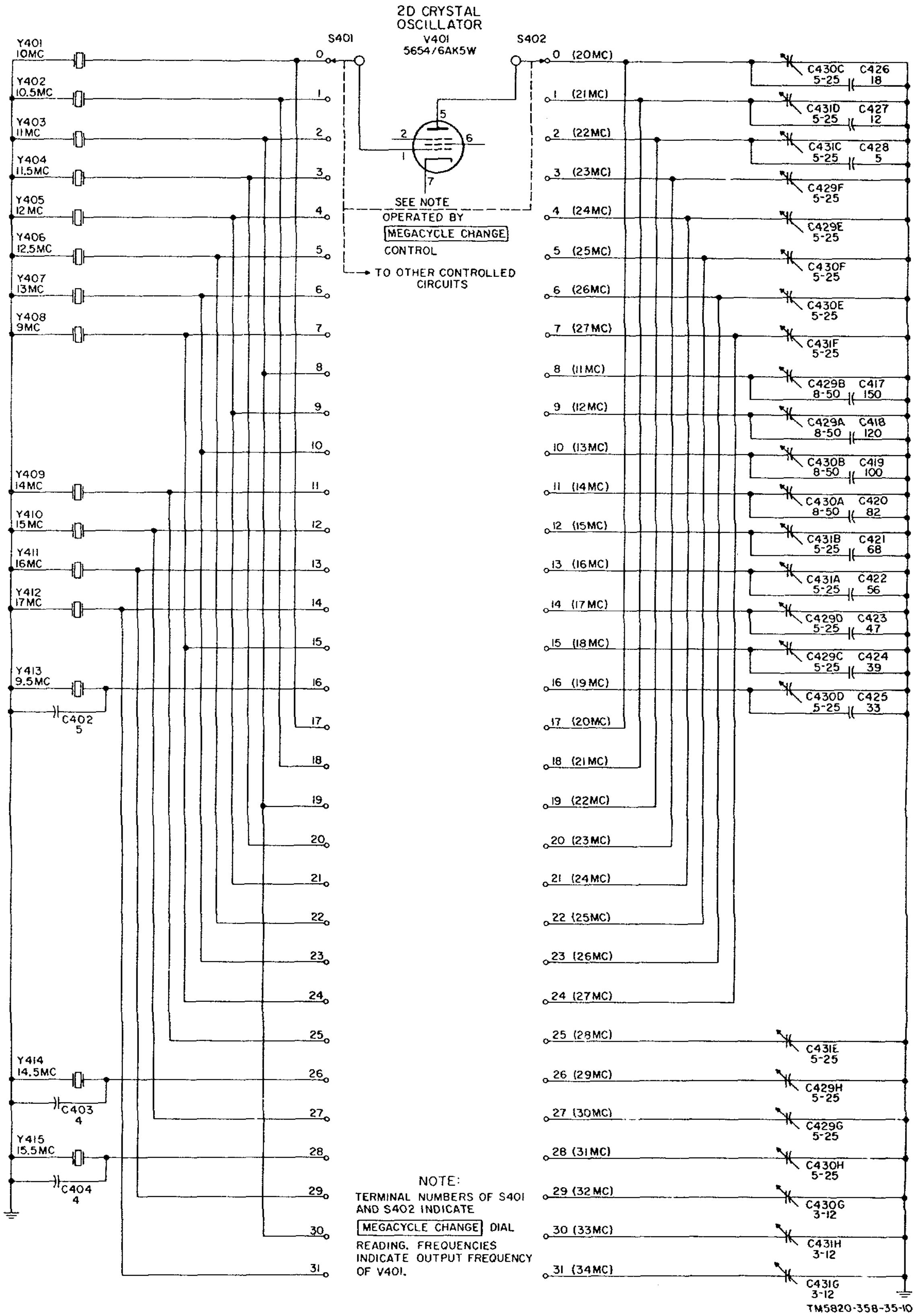


Figure 8. Second crystal oscillator V401, crystal and plate circuit switching, schematic diagram.

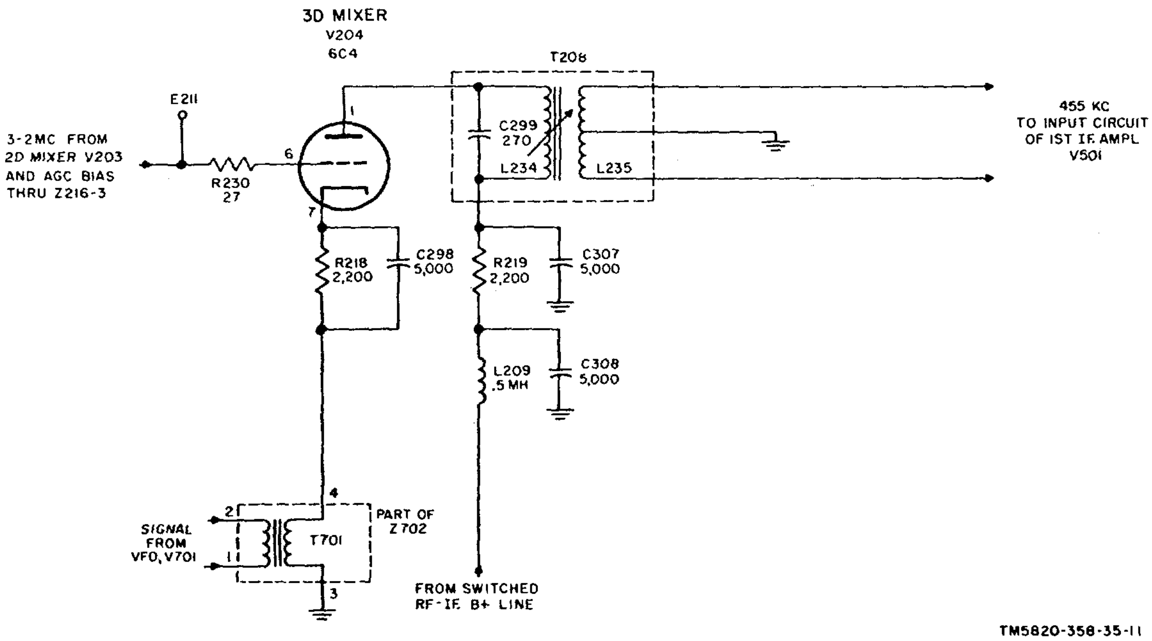


Figure 9. Third mixer V204, simplified schematic diagram.

C714 and R702. Capacitor C705 is the feedback capacitor to the grid tank circuit. The plate voltage for V701 is supplied from the rf-if. B+ line through the plate decoupling network consisting of C707, R703, and C708, and the primary winding of T701.

c. The plate circuit of V701 consists of tuned circuit Z702 which includes the primary of T701 and variable capacitor C706. The secondary coil of T701 and capacitor C709 are shunted by R704. This resistor broadens the response over the range of 3.455 to 2.455 kc so that the output voltage injected into the cathode of the third mixer is essentially constant in amplitude over the frequency range. The output of the secondary of T701 is fed through the combination of R218 and C298 to the cathode of third mixer V204.

d. Coil L701 is tunable, and is the *end-point* adjustment. This adjustment is made at the factory to provide the complete frequency range of precisely 3.455 to 2.455 mc with exactly 10 turns of the vfo tuning shaft. The adjustment of L701 can be used to restore the 3.455- to 2.455-mc tuning range (para 81) if circuit aging causes the 1-mc frequency coverage to change appreciably.

14. Crystal Filter

(fig. 11)

The crystal filter is used to obtain if selectivities of 0.1 and 1 kc. When the BANDWIDTH switch is set to .1 or 1, this filter is connected between the output of third mixer V204 and the input to first if amplifier V501.

a. The 455-kc output signal is coupled from third mixer transformer T208 to crystal filter Z501. The crystal passes only those signals at or very close to 455 kc. Crystal holder and stray capacitances are neutralized by adjusting C520. Coil L503 and capacitor C524 are tuned to 455 kc.

b. When the BANDWIDTH switch is turned to .1, the crystal circuit is loaded by C503 in series with the combination of R502 in parallel with the series combination of C501 and R503. The exact value of R503 is chosen between 560 and 2,700 ohms, to provide a bandwidth of 0.1 kc. When the BANDWIDTH switch is turned to 1, C501 and R503 are removed from

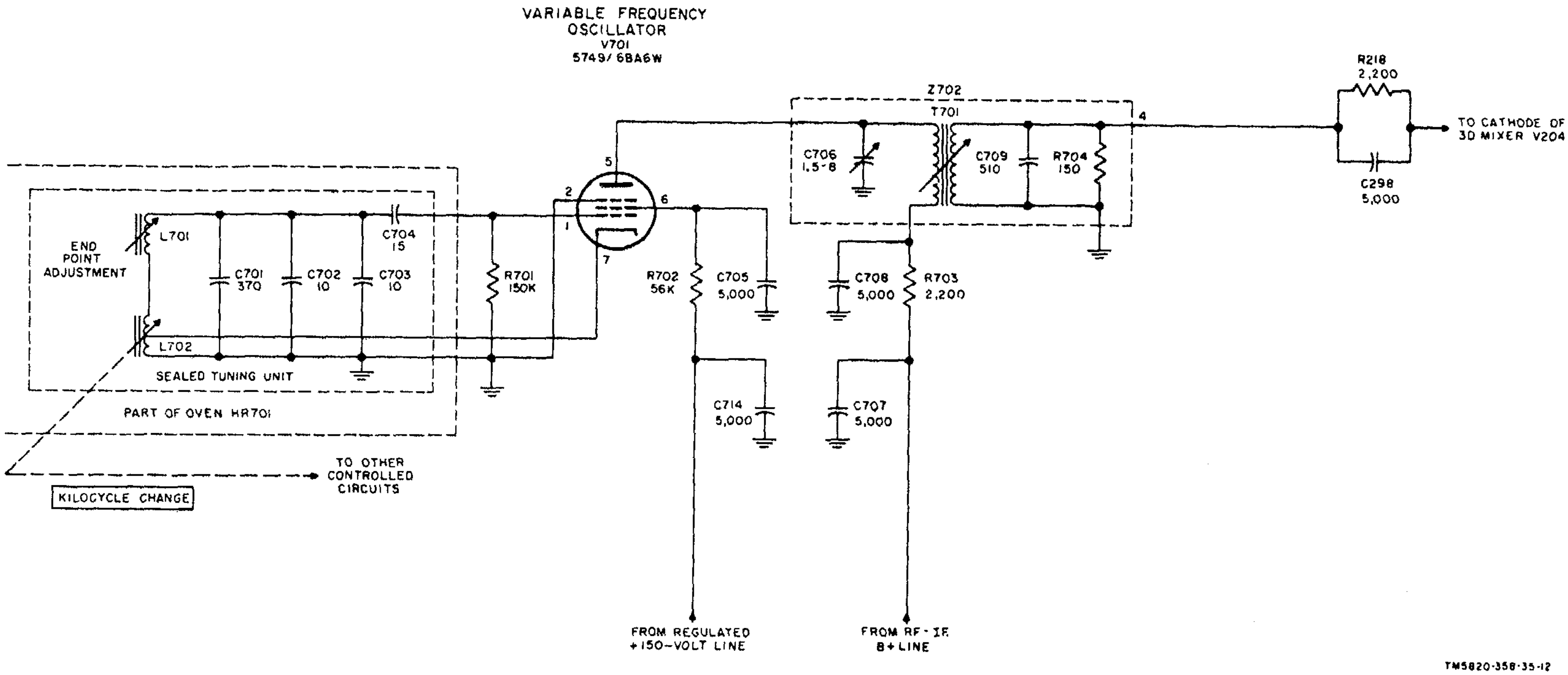


Figure 10. Variable-frequency oscillator V701, simplified schematic diagram.

the circuit, and the bandpass is increased to 1 kc. The value of resistor R502 is selected between 33K and 68K to provide a bandwidth of 1 kc. When the BANDWIDTH switch is turned to 2, 4, 8, or 16, T208 is coupled directly to the control grid of V501 through capacitor C501removingthe crystal from the circuit. Details of selection for 2-, 4-, 8-, and 16-kc bandwidths are given in paragraph 15. Agc bias is fed through the agc filter combination of R501 and C502, and L503 to the control grid, pin 1, of first if. amplifier V501.

15. First If. Amplifier V501 and Mechanical Filters (fig. 12)

First if. amplifier V501 amplifies the 455-kc if. signals from crystal filter Z501.

a. The control grid of V501 is returned to the agc line through the crystal filter circuit (fig. 11). The cathode circuit returns to ground through cathode biasing resistor R504, if. choke coil L501, and RF GAIN control R103. Capacitors C505 and C504 bypass if. signals to ground. The screen grid is connected to the junction of R505 and R506, part of a voltage-divider network, consisting of R506, R505, and the cathode ground return circuit. Capacitor C506 bypasses the screen grid. Plate voltage is obtained through rf choke coil L505 and the decoupling network consisting of R508 and C511. Voltage for the plate and screen circuits is supplied by the switched rf-if. B+ line.

b. Four mechanical filters are coupled to the shunt-fed plate circuit of V501 through coupling capacitor C553 and BANDWIDTH switches S502 and S503. In some later production models of the receiver (para 2), variable trimmer capacitors were added across the input and output circuits of the mechanical filters to improve their tuning (fig. 15). When the BANDWIDTH switch is turned to .1, 1, or 2, 2-kc mechanical filter FL502 is switched into the circuit. The 4, 8, and 16 positions of the BANDWIDTH switch use FL503 through FL505, respectively. The bandpass of the if. amplifiers, and therefore of the entire receiver, is determined by the selection of one of the six switch positions of the BANDWIDTH switch. The very narrow bandwidth 0.1 kc and 1 kc positions of this switch also incorporate the crystal filter (para 14) into the first if. amplifier circuit. Switch S502 (front) connects the plate circuit of V501 to the input of the appropriate mechanical filter, and S503 (front) connects the output of the appropriate filter to the control grid circuit of second if. amplifier V502. Switches S502 (rear) and S503 (rear) short-circuit the input and output terminals of the unused mechanical filters. Capacitors C507 through C510 and C513 through C516 resonate the input and output coils to prevent stray coupling in the unused filters to achieve proper gain and bandpass.

16. Mechanical If. Filters.

a. Magnetostriction is that property of certain materials that causes them to lengthen or shorten when they are in a magnetic field. Mechanical filters of the magnetostrictive type are capable of producing almost ideal bandpass characteristics. Figure 13 shows the bandpass curves of the mechanical filters used in the receiver. The flatter the top and the steeper the sides of the bandpass curve, the better the filter. B, figure 14 shows a comparison between the frequency response curves of a mechanical filter and a conventional tuned circuit.

b. A, figure 14 illustrates the construction of a typical mechanical filter. A signal current is passed through the if. input coil, which causes the driving wire to expand and contract due to magnetostriction. This mechanical motion is transmitted to the disk resonators through the coupling wires. Each disk resonator is sharply resonant (mechanically) to the intermediate frequency, and several such disks, synchronously driven, are used to accomplish the required bandpass. The last disk resonator is tied to the driven wire, which induces the output if. signal into the if. output coil. Biasing magnets are used to adjust the driving wire and the driven wire for the greatest magnetostrictive action.

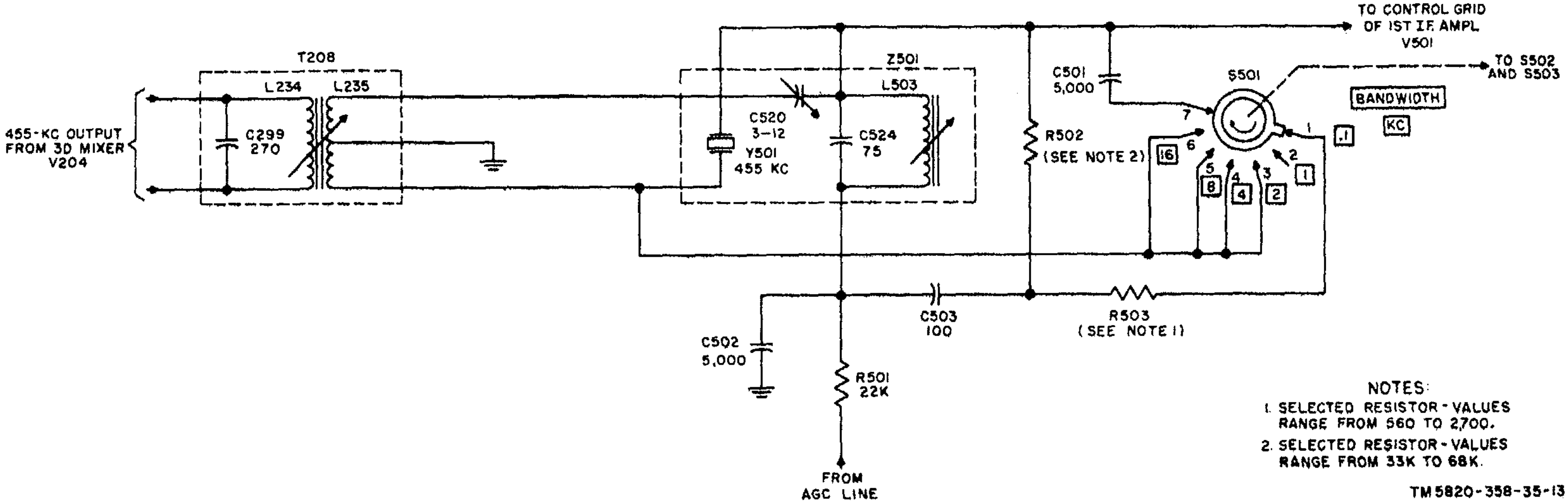


Figure 11. Crystal filter, simplified schematic diagram.

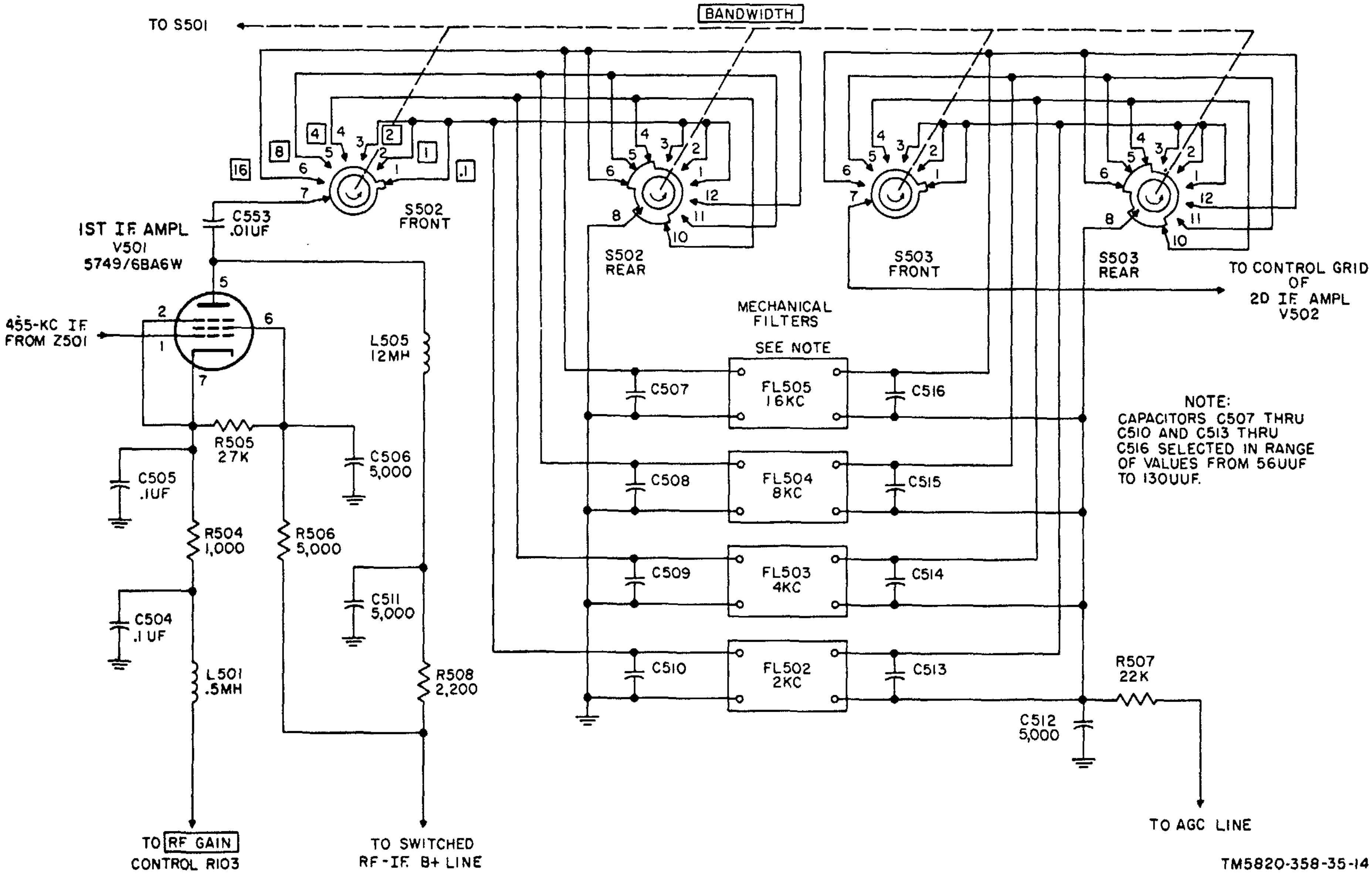


Figure 12. First if. amplifier V501, simplified schematic diagram.

c. The mechanical if. filters used in the receiver are tuned and adjusted at the factory and require no further adjustment. Certain changes to mechanical filters require modification of the external tuning circuits. Refer to paragraph 2 and figure 15.

17. Second, Third, and Fourth If. Amplifiers
(fig. 16)

Second. third, and fourth if. amplifiers, V502, V503, and V504 respectively, amplify (in cascade) the 455-kc signal from first if. amplifier V501. The signal from V504 output transformer T503 is fed to detector V506B (para 18). A second path for the 455-kc signal is from the control grid of V504 to the control grid of if. cathode follower V509B (para 20). The chart below lists the functions and the parts that perform similar functions in the amplifiers. Differences between the stages are discussed in *a* and *b* below.

Function	V502 parts	V503 parts	V504 parts
Cathode bias resistor	R513	R518	R524
Cathode bypass capacitor	C517	C521	C528
Screen bypass capacitor	C518	C522	C529
Screen voltage-divider network	R515, R514	R520, R550	. . . .
Plate decoupling network	R521, C552	R551, C523	R525, C529
If. transformer:	T501	T502	T503
Primary:	L506	L510	L512
Bandspread resistor	R511	R533	R522
Tuning capacitor, fixed	C557	C559	C561
Secondary:	L507	L511	L513
Bandspread resistor	R512	R554	. . . .
Tuning capacitor, fixed	C558	C560	C562

a. The control grid of V502 is returned to the agc line through S503 (front) and the selected mechanical if. filter (fig. 12). The control grid of V503 is returned to the age line through L507 of T501 and R516. The control grid of V504 is returned to ground through L511 (secondary of T502). The screen grid of V504 is fed from the switched rf-if. B+ line through the decoupling network consisting of R525 and C529. The B+ voltage for the plate circuits of V502, V503, and V504 is fed through the primary coils of T501, T502, and T503, respectively.

b. The cathode of V502 returns to RF GAIN control R103 through R513. RF GAIN control R103 adjusts the bias of second if. amplifier V502, rf amplifier V201 (para 7b), and first if. amplifier V501 (para 14a). Screwdriver-adjusted GAIN ADJ control R519, in the cathode circuit of V503, is adjusted during alignment so that the if. amplifiers will yield sufficient amplification (para 73). This adjustment compensates for variations in tube gain and loss 22 of tube gain as a result of aging. The cathode circuit of V504 contains R524 in series with the parallel combination of R537 and screwdriver-adjusted CARR-METER ADJ control R523. The setting of this adjustment has little effect on the gain of V504, as it varies the cathode resistance of V504 only between 680 and698 ohms. Tube V504 and its circuit components are used as one-half of a bridge circuit containing CARRIER LEVEL meter M102 (para 22).

c. Adjustment of if. transformers T501, T502, and T503 is normally not included in the if. amplifier alignment procedure. They are initially tuned during receiver assembly, and should required no subsequent adjustment. The bandwidth of these transformers is sufficiently wide to have negligible effect within the bandpass of even the 16-kc mechanical filter. Their most important function is that of providing attenuation of if. signals more than 8 kc removed from 455 kc. Neutralizing capacitor C525 is adjusted to cancel beat-frequency oscillator signals that might feed

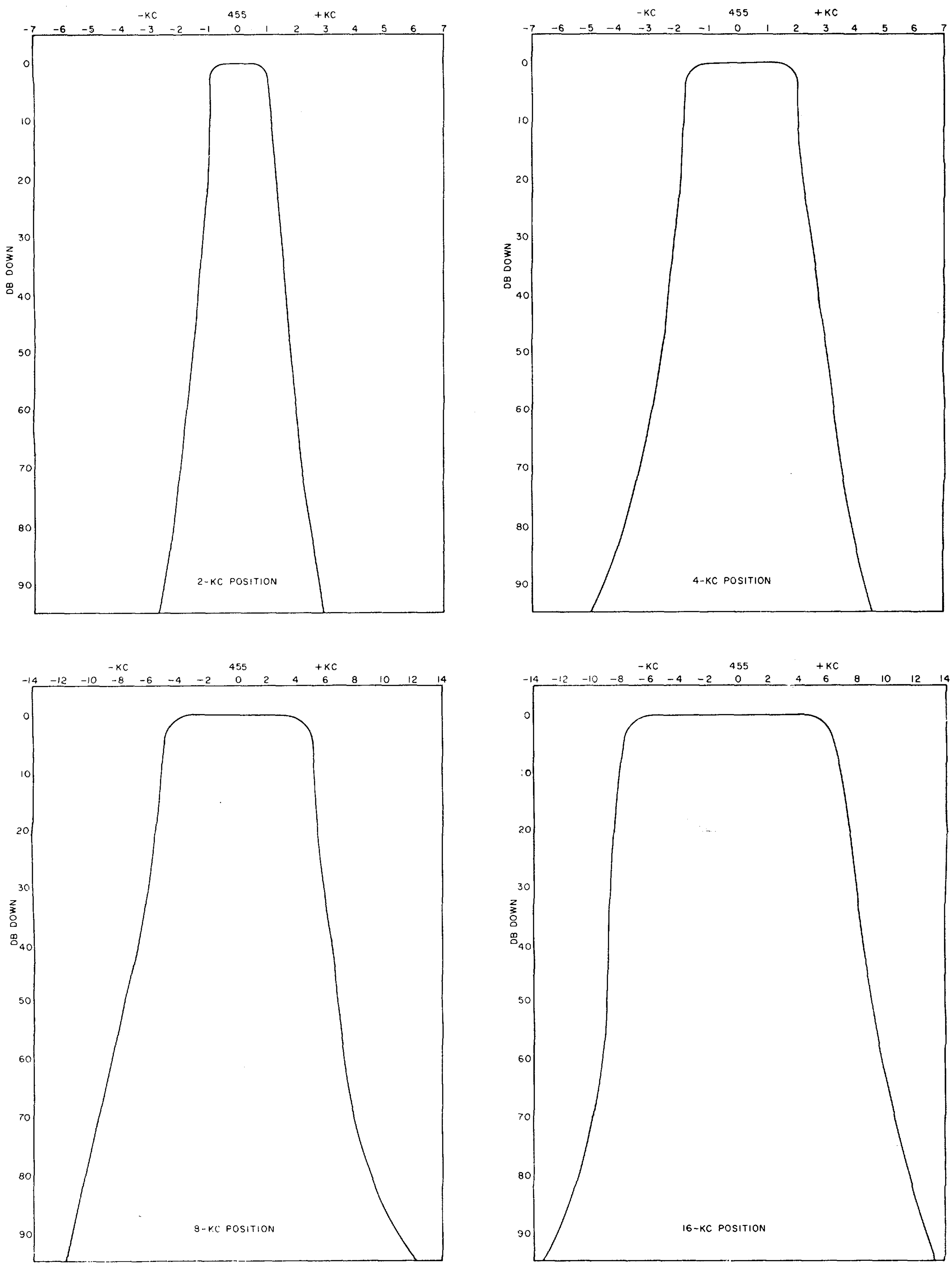


Figure 13. Bandpass of mechanical if. filters.

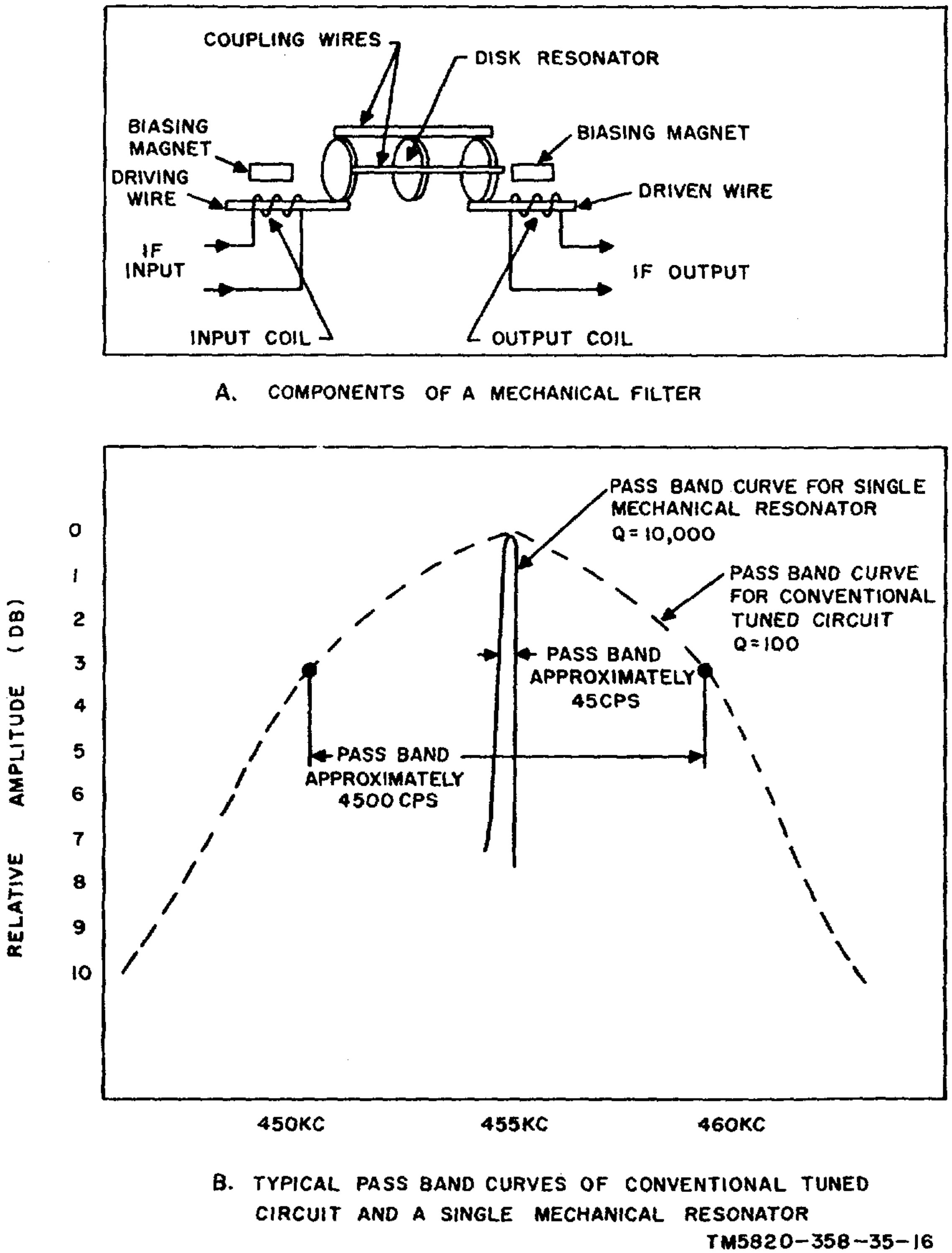
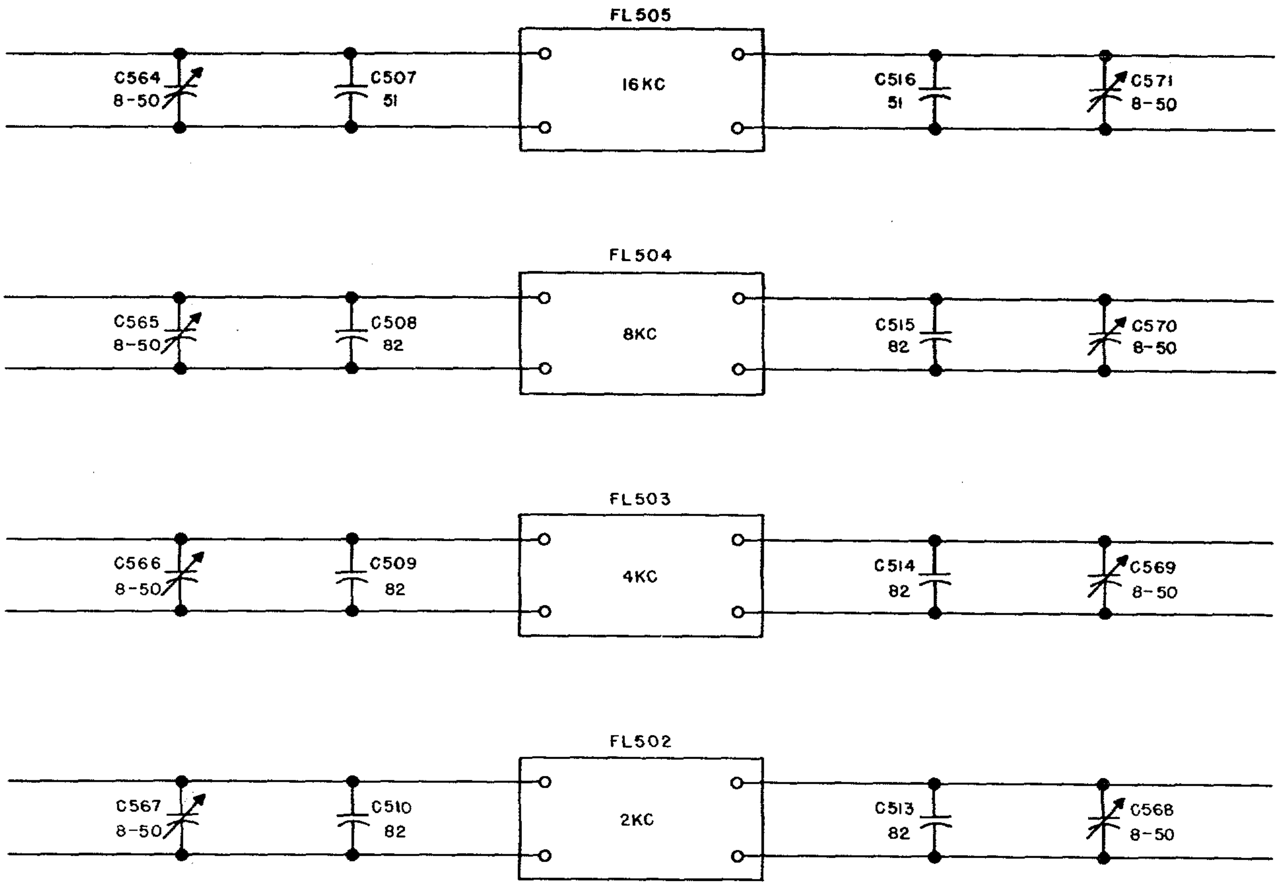


Figure 14. Typical mechanical filters.



NOTES:

1. ALTERNATE TYPE FILTERS USED ONLY ON ORDER NO. 363-PHILA-54, MOD. NO.1 AND ABOVE, AND ALL ON ORDER NO. 14-PHILA-56.
2. WHEN ALTERNATE TYPE FILTERS FL504 AND FL505 ARE INSTALLED, CAPACITORS C507, C508, C515, AND C516 ARE REMOVED FROM THE CIRCUIT. THE ALTERNATE TYPE FILTERS ARE IDENTIFIED BY RED DECALS ON THEIR CASES THAT READ "WHEN USING THIS FILTER, DISCONNECT C508 AND C515 (82UUF)" OR "WHEN USING THIS FILTER, DISCONNECT C507 AND C516 (51UUF)".

TM5820-358-35-15

Figure 15. Modified mechanical if. filters.

back from detector V506B through V504.The secondary winding of T502 also feeds 455-kc signals to if. cathode follower V509B, which supplies 50-ohm, 455-kc signals to external circuits (para 20, fig. 20). The output signal developed across the L513 of T503 is connected to detector V506B. Capacitor C530 bypasses if. signals to ground. In the if. subchassis with MOD numbers 1 and higher on Order No. 363-Phila-54, serial numbers 600 and higher on Order No. 08719-Phila-55, and all if. subchassis on Order No. 14-Phila-56, transformers T501, T502, and T503 are stagger-tuned to increase bandwidth. When one of these transformers is replaced in *any* subchassis, stagger-tuning procedures should be followed (para 72).

18. Detector V506B and Limiter V507
(fig. 17 and 18)

The detector demodulates the 455-kc if. signal to recover the intelligence from the modulated signals. The limiter removes noise pulses that exceed the amplitude of the modulation. The output of the detector passes through the limiter stage before it is fed to the audio channels.

a. Detector V506B is connected as a half-wave diode by connecting the control grid and plate together. The secondary winding (L513) of T503 (fig. 16) feeds the signal from fourth if. amplifier V504 to the detector. The diode load consists of resistors R527 and R526. To connect these load resistors to the stage, the jumper at DIODE LOAD terminals 14 and 15 on TB103 must be in place. Capacitor C530 and choke coil L502 are an if. filter used to remove if. signals from the detected audio.

b. The if. signal current path is from L513 through L502, terminals 14 and 15 of TB103, R527, R526, to chassis ground, to pin 8 of V506B, through V506B to pins 6 and 7, and back to L513. The polarity at DIODE LOAD terminals 14 and 15 is negative with respect to chassis ground.

c. Audio signals are taken from the junction of R527 and R526, and coupled through C531 to limiter tube V507. Limiter V507 is a series-type diode limiter, which couples the audio signals from the detector to the audio channels. When LIMITER switch S108 is in the OFF position, audio signals pass through V507 without any limiting action. When switch S108 is turned on, the amount of limiting is controlled by LIMITER control R120.

(1) The limiter uses both sections of a twin-triode tube. The B-section of the tube is the negative peak limiter, and the A-section is the positive peak limiter. The limiter removes noise peaks above the level of the modulation. When the LIMITER control is set at the OFF position, switch S108 grounds cathode resistor R535. At the same time, B+ voltage from the switched rf-if. B+ line is applied to the diode plates through their plate resistors R532 and R533, common resistor R534. Audio signals from the detector diode load pass to the plate of V507B and superimpose the audio on the B+ voltage at the plate. This audio signal causes the cathode of V507B to follow it without limiting the audio signal. Capacitors C532 and C537 bypass any remaining if. signal. Since the cathodes of both sections of the tubes are tied together, the cathode of V507A modulates the plate current of this section of the tube. The audio signal is developed across R533 and is then coupled through C549 to the grid of first af amplifier V601A.

(2) When the LIMITER control is turned clockwise, switch S108 removes the chassis ground from the bottom R535 and short-circuits B+ to ground at the junction of R534, R532, and R533. The entire B+ voltage appears across R534.

(3) A long time-constant network, consisting of R119 and C101, removes the audio component of the voltage fed to the cathodes of V507. The cathodes assume an average negative dc (with respect to chassis ground) threshold voltage which

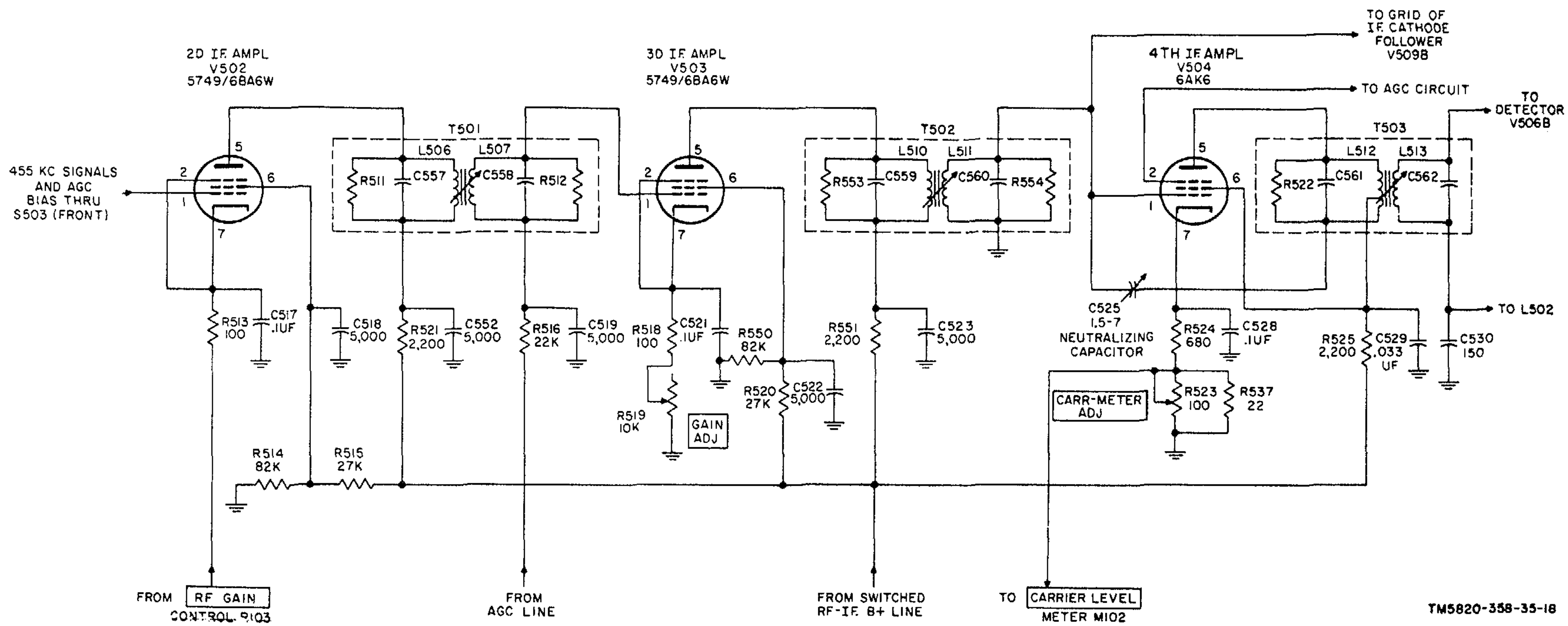


Figure 16. Second, third, fourth if. amplifiers V502 through V504, simplified schematic diagram.

depends on the setting of the LIMITER control, signal input.-level, and the received signal modulation percentage. The dc threshold voltage is equal to, or greater than, the peak-to-peak audio signal level at the junction of R527 and R526. This causes the plate of V507B to be positive in respect to its cathode, and current flows through V507B. The cathode of V507A is connected to the cathode of V507B and both are negative with respect to chassis ground. The plate of V507A is at chassis ground potential and is thus positive with respect to its cathode. The tube conducts and the audio signal is fed through C549, to the control grid of first af amplifier V601A.

(4) When a negative noise peak of greater amplitude than the do threshold voltage is received, the plate of V507B is driven negative with respect to its cathode. The tube stops conducting and the noise peak does not appear at the control grid of V601A.

(5) When a positive noise peak of greater-amplitude than the dc threshold is received, V507B conducts heavily, and causes the cathode of V507A to become more positive than the plate of V507A. The tube stops conducting and the positive noise peak does not appear at the control grid of V601A.

(6) Both positive and negative noise peaks are clipped. As the LIMITER control is turned more and more clockwise, the dc threshold voltage approaches chassis ground potential and more severe clipping occurs. Figure 18 shows that the audio signal as well as the noise will be clipped if the LIMITER control is turned too far clockwise. The circuit automatically adjusts to any level of signal input and modulation percentage

19. Beat-Frequency Oscillator V505 (fig. 19)

Beat-frequency oscillator V505 generates and couples, through capacitor C535, stable signals variable from approximately 452 kc to 458 kc (3 kc above and 3 kc below the intermediate frequency). This range of frequencies beats with the 455-kc if. signal at detector V506B to produce audio signals variable from 0 to 3,000 cycles.

a. The oscillator circuit is an electron coupled Hartley-type oscillator. Coils L508 and L509 with capacitors C554, C556; and C555, and with the addition of input capacity and compensation capacitor C527, are the basic frequency-determining elements of the circuit. Inductive feed back is accomplished through tapped tank coil L508. Resistor R528 and capacitor C526 develop grid-leak bias. Tuned circuit Z502 is sealed for maximum protection and reliability. The BFO PITCH control tunes Z502 by moving a powdered-iron core in L508.

b. Capacitor C533 is the feedback capacitor and resistor R529 is the screen voltage-dropping resistor. Resistor R530 is the plate load for the circuit. Resistor R531, with capacitor C534, forms a plate decoupling circuit. The voltage for the plate and screen grid is obtained from the switched rf-if. B+ line, and is completed through BFO switch S101 when the switch is in the ON position.

20. If. Cathode Follower V509B (fig. 20)

Cathode followers generally do not amplify; they are used as impedance-matching devices. If. cathode follower V509B provides a 50-ohm, 455-kc if. output signal for use with a frequency-shift converter in a teletypewriter system. This stage has negligible loading effect on if transformer T502, which also feeds the grid of fourth if. amplifier V504.

a. The input circuit of V509B is L511 of T502. The plate circuit is decoupled and bypassed to ground by R539 and C541; plate voltage is obtained from the switched rf-if. B+ line.

b. Two signal output connections are made to the

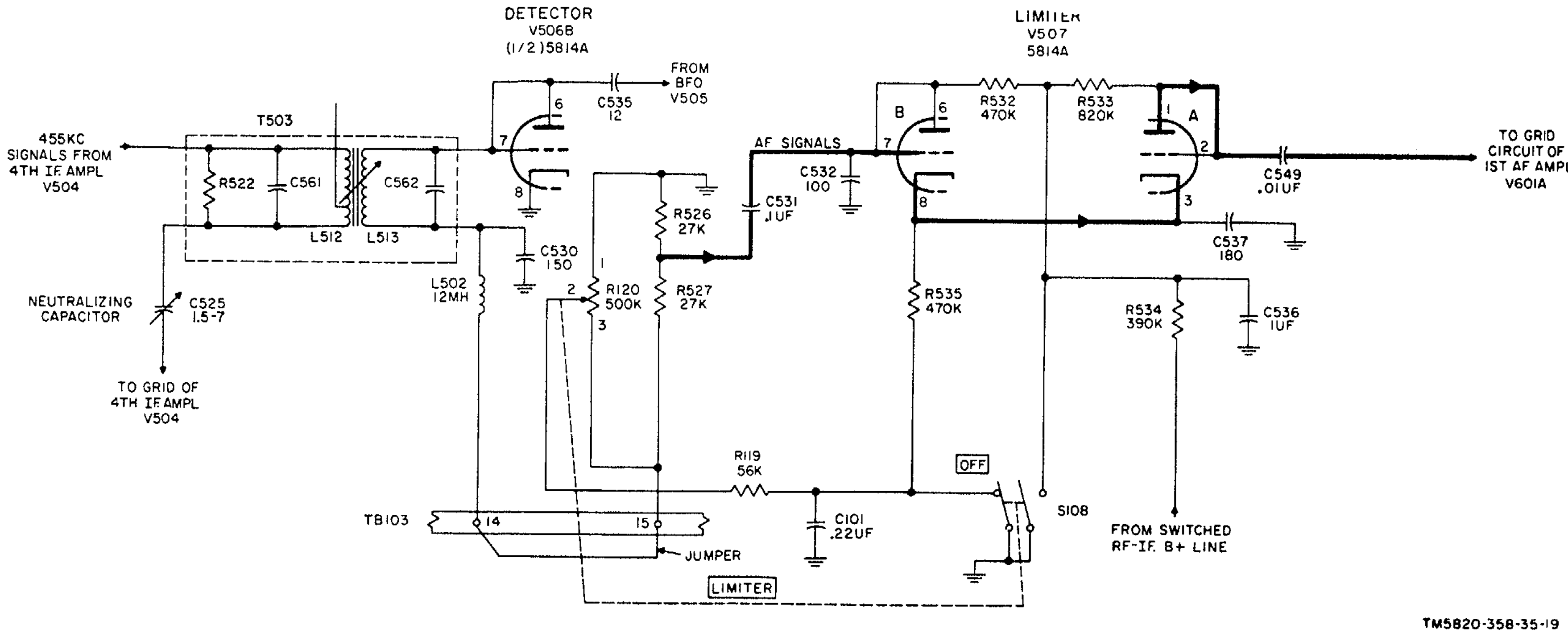


Figure 17. Detector V6506B and limiter V507, simplified schematic diagram.

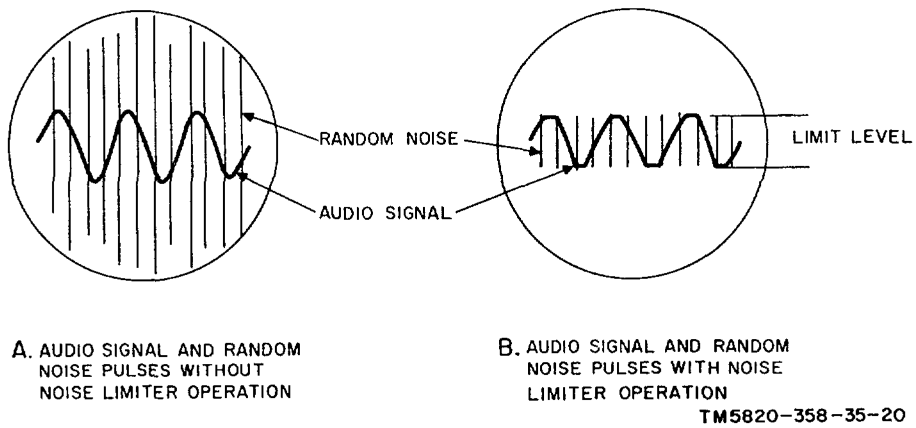


Figure 18. Typical oscilloscope presentation of limiter operation.

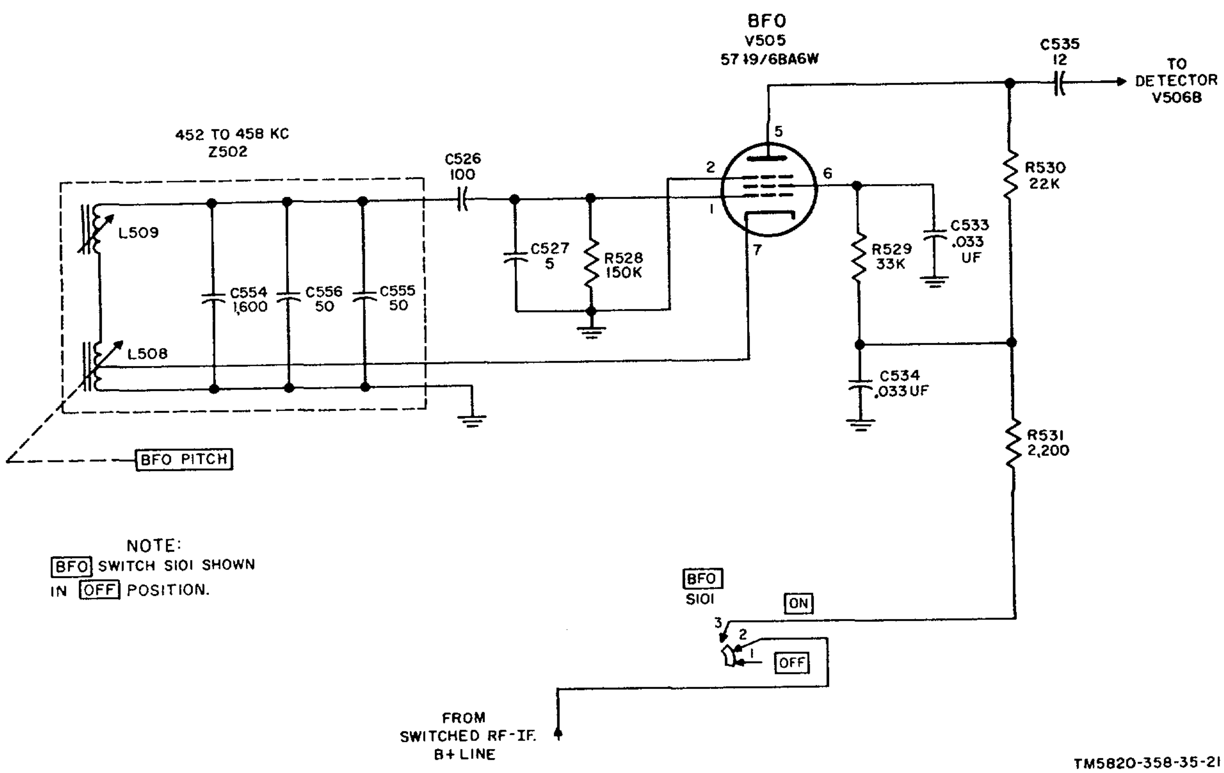


Figure 19. Beat-frequency oscillator V505, simplified schematic diagram.

low-impedance cathode circuit of this stage. The first output is developed across the 455-kc tuned circuit which consists of coil L504 and series connected capacitors C539 and C540. The IF OUTPUT connector at the rear panel of the receiver is connected to the junction of C539 and C540 through resistor R552, providing an if. output impedance to match a 50-ohm load. Resistor R538 develops cathode bias which maintains the tube operating current at a safe level. A second 455-kc if. signal is taken directly from the cathode through capacitor C542 to the grid of agc if. amplifier V508. The cathode follower stage isolates the agc if. amplifier from fourth if. amplifier V504, preventing
interaction between the two stages.

21. Automatic Gain Control Circuit (fig. 21)

When the receiver front-panel FUNCTION switch is set to the AGC position, age bias is fed to the control grid circuits of tubes V201 through V204 in the rf subchassis and to tubes V501, V502, andV503 in the if. subchassis. This age bias controls the gain of the tubes in the rf and if. subchassis in proportion to the average level of the incoming rf signal. Signals appear to have a relatively constant signal strength. The agc circuit operates only for signals in excess of approximately 5 microvolts, in order not to reduce the receiver gain when receiving extremely weak signals. The AGC switch on the front panel of the receiver allows the operator to select one of three age time-constant characteristics. These p o s it ions are SLOW, MED, and FAST, and are approximately 5 seconds, 0.3 second, and 0.015 second, respectively. This feature enables the operator to choose the agc time constant which most effectively compensates for fading rf signals. Three tubes are used in the age circuit: age if. amplifier V508, which amplifies the voltage from if. cathode follower V509B; agc rectifier V509A, which rectifies the output of V508; and age time constant tube V506A, which lengthens the time constant of the age circuit when the AGC switch is set to the SLOW position.

a. Agc If. Amplifier. This stage (V508) amplifies the if. signal from if. Cathode

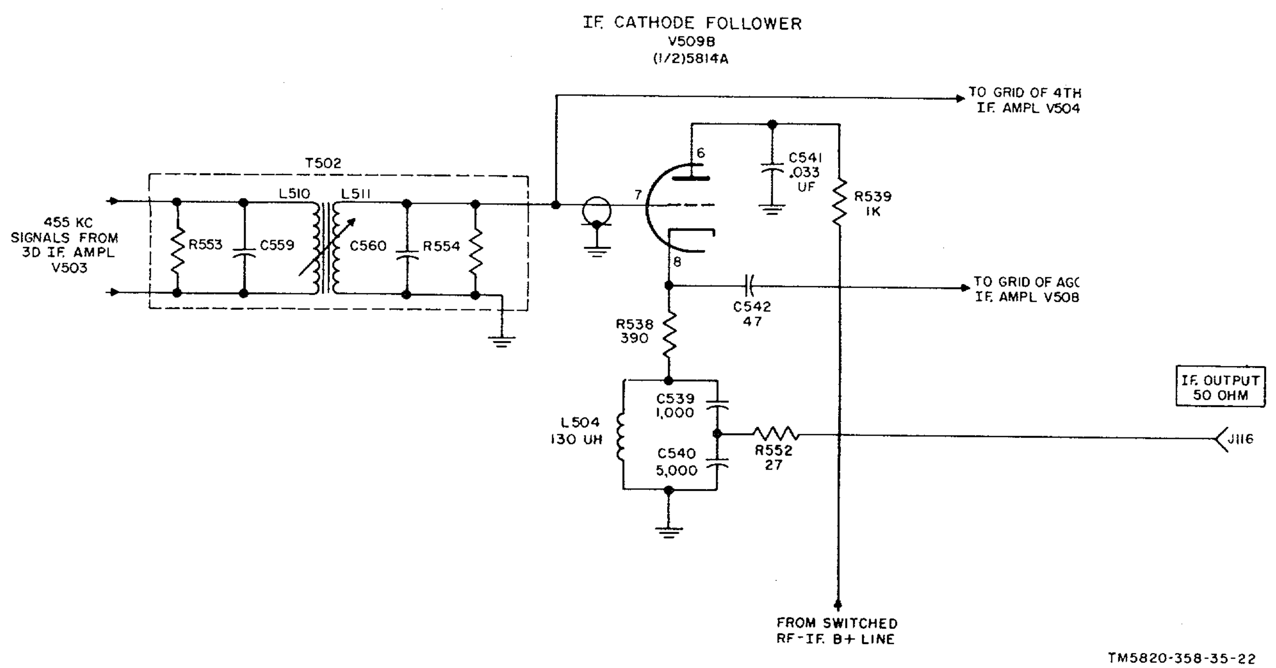


Figure 20. If. cathode follower V509B, simplified schematic diagram.

follower V509B. This signal is coupled through capacitor C542; R540 is the grid return resistor to ground. Screen grid voltage is dropped and decoupled by the combination of R543 and C544. Resistor R541, bypassed by C543, provides cathode bias for V508. The developed age bias from the junction of R546 and R547 is connected to the suppressor grids of V504 and V508 to use them as positive clamps to prevent the age line from going more than a few volts positive. Plate voltage for V508 is fed from the switched rf-if. B+ line through the decoupling network of R542 and C545, and tuned circuit Z503. Tuned circuit Z503 is tuned to 455 kc. The amplified if. output of V508 is coupled to the age rectifier through capacitor C546.

b. Delayed Agc. The purpose of delaying the application of age to the rf and if. circuits is to prevent the controlled tubes from having their gain reduced unless the incoming rf signal is 5 microvolts or stronger.

(1) The age delay depends on the action of the voltage divider from the B+ line, consisting of R544, R546, and R545. A slightly positive dc voltage is present at the junction of R546 and R547 and on the suppressor grids of V504 and V508. Contact potential developed at the grid of V506A reduces the positive voltage on the age line, and may make it slightly negative, depending on the age and condition of the tube. This positive delay voltage offsets any low level age bias that is developed at the junction of R546 and R547 because of weak signals.

(2) When the positive peaks of the 455-kc signal are applied to the age rectifier, the tube will conduct and effectively place a low impedance to ground at the junction of R545, R546, and C546, putting a negative charge on it. On the next half-cycle, when the 455-kc signal goes negative, V509A will not conduct and current will flow from C546 through R545 to ground, making the junction of R545 and R546 negative with respect to ground. The amplitude of this negative voltage depends on the received signal strength and the positive voltage which is being developed simultaneously at this junction by the B+ voltage divider action. If the developed age voltage is larger, a negative voltage will appear at both ends of isolation resistor R547 and also on the age line. Capacitor C547 bypasses to ground any audio or 455-kc signals appearing at the junction of R546 and R547.

(3) Stronger 455-kc signals (depending on the strength of the incoming rf signals) cause larger currents to flow through R545, and thereby charge C547. Substantial age bias will be developed and fed through AGC NOR terminals 3 and 4 of TB102, to the first three if. amplifiers (V501, V502, and V503) in the if. subchassis, to the rf amplifier, and to the three mixer stages (V201 through V204) in the rf subchassis.

(4) When the FUNCTION switch is in the AGC position, the age bias is applied to the controlled stages. When the FUNCTION switch is in the MGC position, the age line and the grids of the controlled stage are grounded and no age bias is applied to the controlled tubes. Under this condition, the only control of the receiver rf and if. gain is through the use of the receiver front-panel RF GAIN control.

c. Time-Constant System. Three levels of age time constant are available. They are controlled by the AGC control; the three positions are FAST, MED, and SLOW. The time constants are approximately 0.015 second, 0.3 second, and 5 seconds, respectively.

(1) FAST. In the FAST position, a minimum length of time is required by the age circuits to follow fast-fading rf signals. With the AGC switch in this position, the time constant depends on the resistance-capacitance (re) combination of R546 and C547, and R547

and C548, as well as each of the agc decoupling circuits for the individual controlled stages.

(2) MED. In the MED (medium) position, the age line is influenced by the same rc combinations as in the FAST position, plus the additional capacitance of C551 in parallel with C548 through 'AGC switch S107, terminals 7 and 9.

(3) SLOW. In the SLOW position, the time required by the agc line to follow the fading signal is maximum. This is often useful for holding the receiver gain constant with on-off keying, which would otherwise raise the noise level between characters. In the SLOW position, the rc combination used in the FAST position is used, plus the time constant produced by capacitor C551 connected to the plate of agc time constant tube V506A rather than to ground as in the MED position. The time constant in the SLOW position is approximately 16 times that achieved in the MED position. As the agc bias at the control grid of V506A goes more negative, the voltage drop across plate resistor R549 decreases and the plate voltage of V506A rises. At this point, capacitor C551 begins to charge to the level of the agc voltage, as referenced to the B+ level at the plate of V506A. As this charging advances, the plate voltage of V506A continues to rise, and C551 continues charging to the new plate voltage level. This bootstrap action continues until the grid of tube V506A reaches the level of voltage at the junction of R546 and R547. The rate of discharge of C551 is also retarded in the same way since it must discharge through V506A.

d. Diversity Circuit. When two receivers are used in a diversity reception system, the jumper on TB102 (fig. 21), normally connected between terminals 3 and 4, is connected between terminals 4 and 5. This connects crystal diode CR101 into the circuits to prevent loading of the age circuit of the controlling receiver by the age circuit of the passive receiver.

22. CARRIER LEVEL Meter Circuit (fig. 22)

CARRIER LEVEL meter M102 indicates the relative strength of the received rf signal. Fourth if. amplifier V504, agc time-constant tube V506A, and their circuit components form a bridge circuit.
Meter M102 indicates the bridge unbalance.

a. With no received rf signal and with the RF GAIN control turned fully counter clockwise, the current through V504 is adjusted, with CARR-METER ADJ R523, until M102 reads zero. Under these conditions, the voltages at points A and B are equal and no current flows through M102. As an rf signal is applied to the receiver (RF GAIN control fully clockwise), age voltage is applied to V506A, and its plate current and the voltage drop across R548 decrease. This causes the voltage at B to become more positive than the voltage at A. The greater the amplitude of the rf signal, the greater the difference in potential between B and A, and the larger the indication of M102. Thus, M102 indicates a relative value proportional to the received rf signal.

b. For one half of the bridge circuit, electron current flows from ground through R548, V506A, and R549 to the switched rf-if. B+ line. For the other half of the bridge circuit, electron current flows from ground through the parallel combination of R537 and R523, R524, V504, L512 of T503, and R525 to the switched rf-if. B+ line. When the FUNCTION switch is in the MGC position, the control grid of V506A, is grounded (fig. 89), and the CARRIER LEVEL meter will read zero unless the signal input to the control grid of V504 is large enough to draw grid current. This condition indicates an overload, and the RF GAIN control should be turned counterclockwise until the CARRIER LEVEL meter indicates zero again.

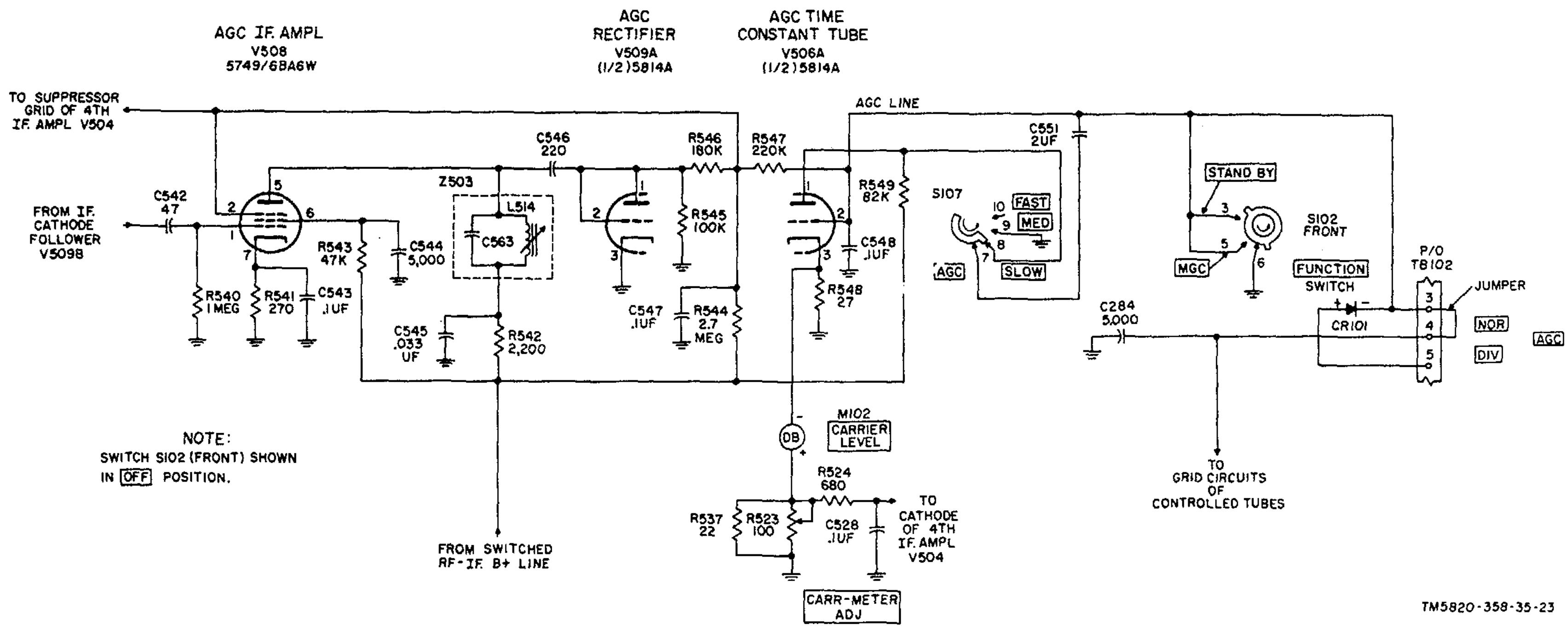


Figure 21. Agc circuit, simplified schematic diagram.

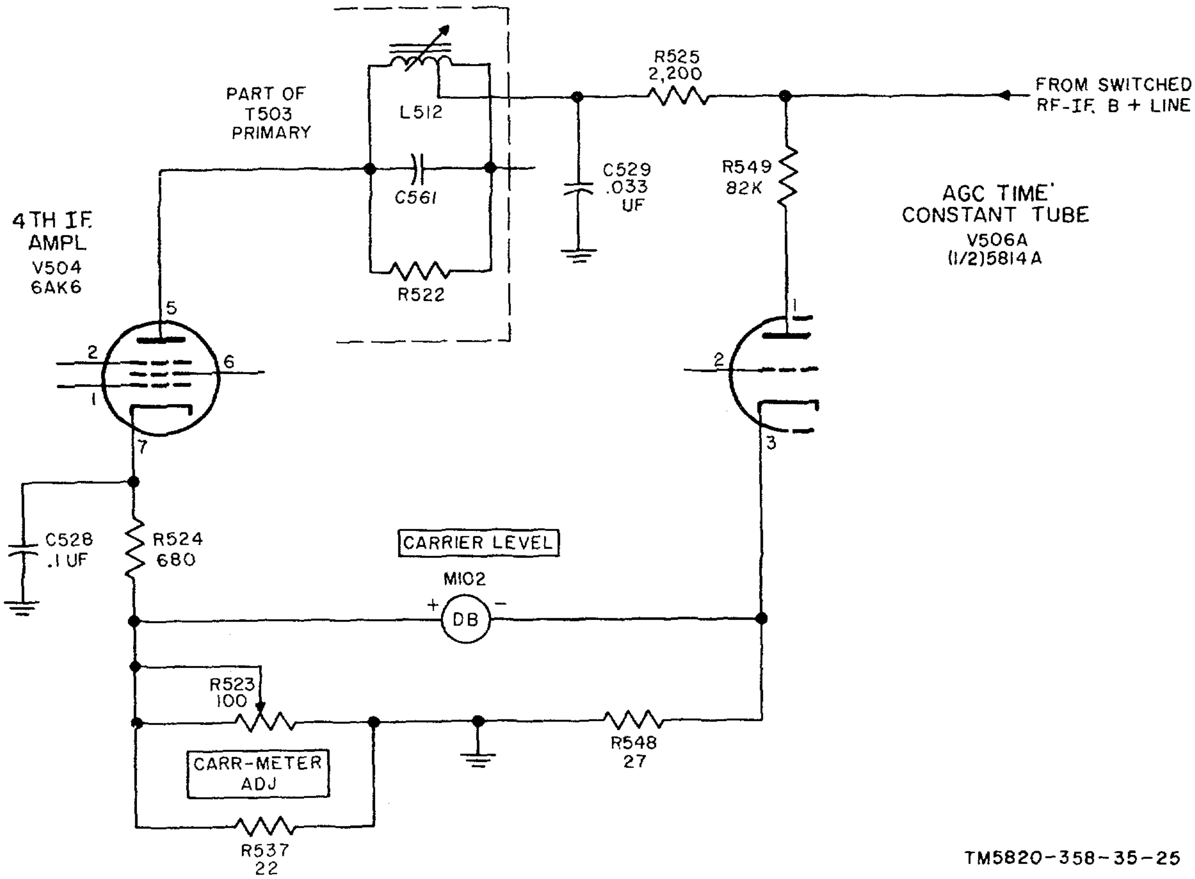


Figure 22. CARRIER LEVEL meter circuit. simplified schematic diagram.

23. First Af Amplifier and Af Cathode Follower (fig. 23)

The purpose of these two stages is to amplify the audio signals and to provide a circuit that will distribute the audio signals to the local and line audio channels. The gain of V601A is less than 10 decibels (db), and the gain of V601B is less than unity.

a. Audio signals from limiter tube V507 (fig. 17) are fed through isolation resistor R601 to the control grid of V601A. Resistor R603 is the grid return resistor and R604 and C609 are the cathode-biasing resistor and bypass capacitor, respectively. Resistor R605 is the plate load resistor. Decoupling and hum filtering are accomplished with R606 and the two sections of electrolytic capacitor C603. The audio output of V601A is coupled through C602, to terminal 1 of AUDIO RESPONSE switch S104, and is either fed through the switch through terminals 3, 9, and 7 to the control grid of af cathode follower V601B (WIDE position), or through the switch terminals 1 and 2, and 800-cps bandpass filter FL601 (SHARP position), switch terminals 8 and 7, to the control grid of af cathode follower V601B. On some models (para 2), C612 is added in parallel with R601 in order to boost the higher audio frequencies which were attenuated in the limiter circuit.

b. Resistor R607 is the control grid return for af cathode follower V601B. The cathode of V601B is connected to ground through cathode resistor R627, in series with parallel-connected potentiometers R104 and R105. These are respectively the LINE GAIN and the LOCAL GAIN controls on the receiver front panel. The line audio signals are taken from the arm of potentiometer R104 through coupling capacitor C607 to the control grid of line af amplifier V602B. Local audio signals are fed from the arm of potentiometer R105 through coupling capacitor C604 to the control grid of local af amplifier V602A. Grid return resistor R608 of af cathode follower V601B is connected from the control grid to the junction of R627 and the parallel combination of the LOCAL GAIN and LINE GAIN controls. Sufficient cathode bias prevents excessive plate current from flowing when the BREAK IN switch (fig. 26) causes the contacts of relay K601 to close and ground the lower end of R627. When S104 is in the WIDE position, capacitor C601 and resistor R602 feed the audio signal present at the junction of R627, R608, R104, and R105 to the control grid of the first af amplifier through S104 terminals 4 and 6. This introduces negative feedback into the V601A circuit and reduces the gain of this stage approximately 5 db. This loss of gain is comparable to the loss in FL601 in the SHARP position. The negative feedback also reduces distortion in these two stages.

24. Local Audio Channel
(fig. 24)

a Local Channel Audio Amplifiers. Audio signals are fed to the control grid of af amplifier V602A from LOCAL GAIN control R105 through coupling capacitor C604. The grid return for V602A is through R609. Cathode bias is provided by R610 and R615. The amplified audio output of V602A is developed across plate load resistor R611 and coupled through C605 to the control grid of V603. The grid return for V603 is through R613. Cathode bias is provided by R614 and R615. Plate voltage for V603 is applied through the primary of T601, which serves as the plate load. Plate and screen grid voltages are supplied from the AF B+ line.

b. Local Channel Output Circuits. The audio signals are induced in the series connected secondary windings of T601 and are fed from terminals 3 and 6 LOCAL AUDIO terminals 6 and 7 of TB102. This audio output supplies at least 500 milliwatts to a 600-ohm load. The same audio signals are applied through an attenuation circuit consisting of R101 and R102 to terminals 7 and 8 of TB102 (PHNS terminals), and PHONES jack J102 on the receiver front panel. This power output is at least 1 milliwatt.

c. Feedback Paths. Three feedback paths are used in the local audio channel to improve impedance matching and to stabilize the gain of this channel. The first feedback circuit is regenerative and is accomplished by the use of resistor R615 as a common cathode resistor for V602A and V603 The second feedback path is degenerative through resistor R612 from the plate of V603 to the cathode of V602A. The third feedback circuit, also degenerative, is accomplished by not bypassing the cathodes of V602A and V603.

25. Line Audio Channel
(fig. 25)

The operation of the line audio channel is identical with that of the local audio channel (para 24), with the exception of the output circuits. Corresponding parts perform corresponding functions. Only the output circuits of the line audio channel will be discussed.

a. The audio signals developed in the primary windings are induced in the secondary winding of T602. Terminals 4 and 5 of the secondary are connected to TB103 terminals 12 and 11, respectively. A jumper between TB103 terminals 12 and 11 connects the two secondary windings in series. The series-connected secondary windings match a 600-ohm load. The audio signals from T602 terminals 3 and 6 are fed through a 14-db H-type attenuator to LINE AUDIO TB103 terminals 13 and 10, respectively. Five resistors, R111 through R115, are the circuit elements of the H-type attenuator. The maximum audio power output available at TB103 terminals 10 and 13 is at least 10 milliwatts.

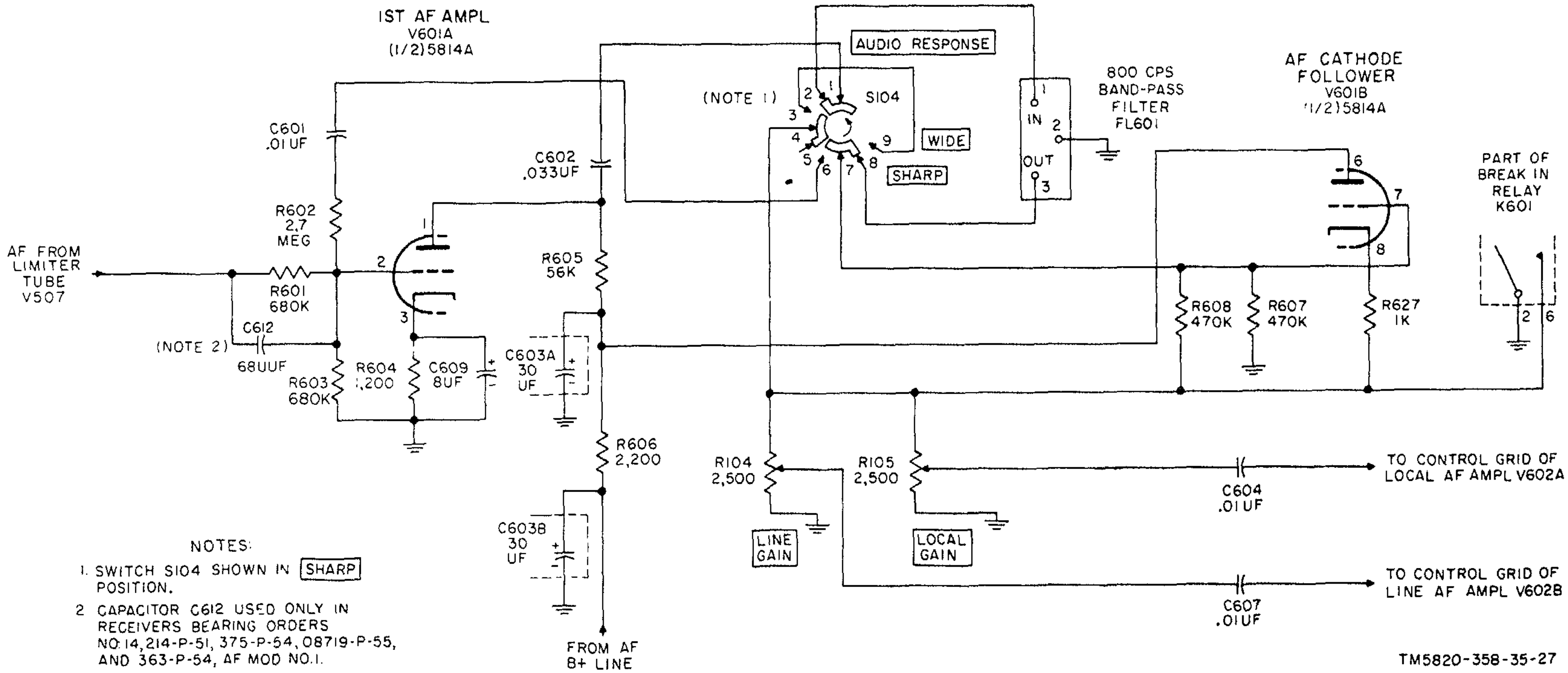


Figure 23. First af amplifier V601A and af cathode follower V601B, simplified schematic diagram.

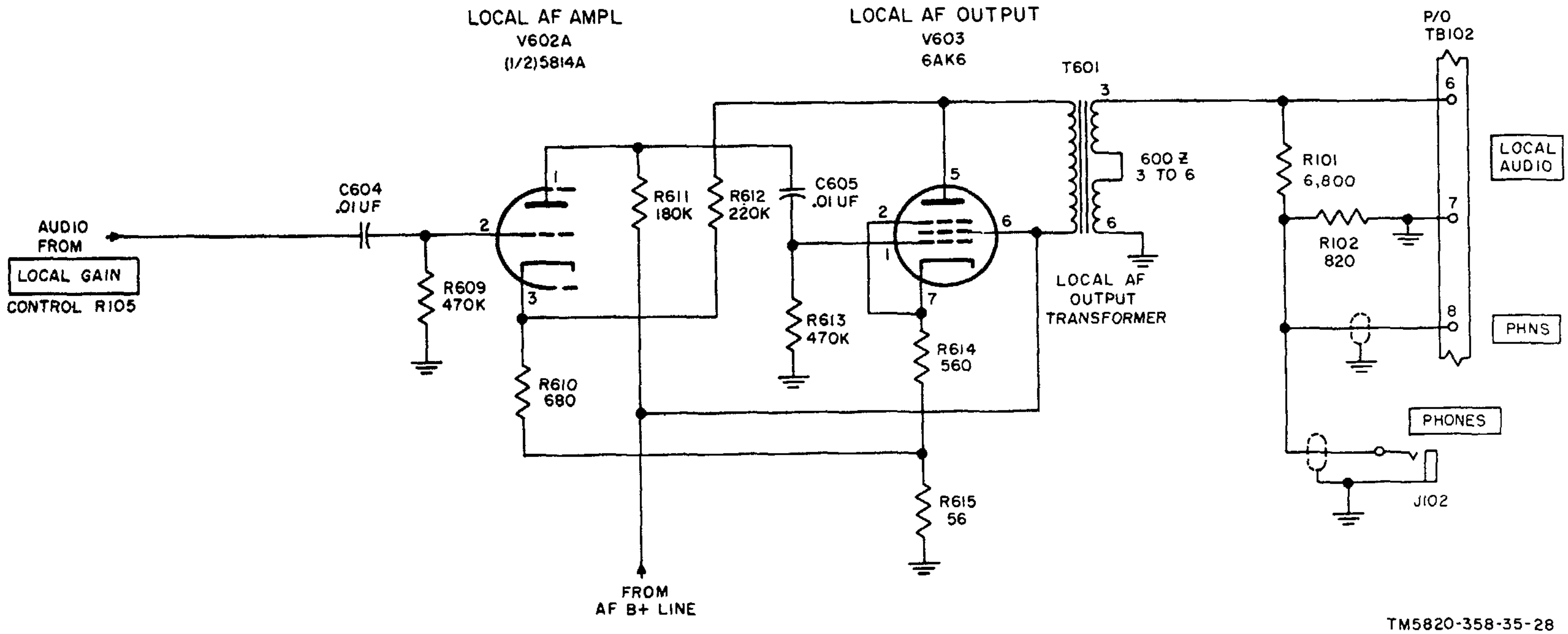


Figure 24. Local audio channel, simplified schematic diagram.

b. The audio signal at T602 of terminal 3 is fed to terminal 7 of one of the two segments of LINE METER switch S105 through resistor R110, This switch has four positions: OFF, +10, 0, and -10. The schematic diagram in the lower left-hand corner of figure 25 shows the equivalent circuit for each position of LINE METER switch S105. When in the OFF position, R109 and R110 load the secondary of T602, and LINE LEVEL meter M101 is out of the circuit. In the +10 position, resistors R106, R108, and R110 are placed across the T602 secondary, and M101, in series with R107, measures the voltage across R106. In the 0 position, a similar circuit combination is used, except that R110, R117, and R118 are in series across T602; and M101, in series with R116, measures the voltage across R118. In the -10 position, LINE LEVEL meter M101 and series connected resistor R110 are placed directly across the secondary winding of T602.

c. LINE LEVEL meter M101 is calibrated in volume units (vu), which are based on a zero reference level pure sine wave of 1 milliwatt (mw) into 600 ohms, or 0 decibels (referred to 1 milliwatt in 600 ohms) (dbm). For example, a reading on the LINE LEVEL meter of -10 vu is equal to -10 dbm. A reading of +2 vu is equal to +2 dbm. When LINE METER switch S105 is set at the 0 position, the LINE LEVEL meter is read directly. When LINE METER switch S105 is set at the -10 position, subtract -10 vu from the meter reading, and similarly, add +10 vu to the meter reading when S105 is set at the +10 position.

26. Break-In Circuit (fig. 26)

When the receiver and a radio transmitter are operated as a radio set, the antenna is disconnected from the receiver and grounded by the break-in circuit when the transmitter is keyed. This circuit also grounds the audio input to the local and line audio amplifiers.

a. When BRK IN terminal 9 of TB103, on the receiver rear panel, is grounded through GND terminal 16, and BREAK IN switch S103 is at ON, current will flow from the 6.3-volt ac filament circuit through the coil of break-in relay K601, terminals I and 7, terminals 2 and 3 of S103, and terminals 9 and 16 of TB103 to ground.

b. When break-in relay K601 is operated, terminal 2 contacts terminal 6, and terminal 3 contacts terminal 4. Terminals 2 and 6 of K601 silence the receiver by grounding the audio signal input to the local and line af amplifier stages at the junction of R627, LINE GAIN control R104, and LOCAL GAIN control R105. Terminals 3 and 4 complete the circuit to ground for the 25.2 volts ac fromT801throughbridge rectifier CR102, energizing K101 (para 6). This disconnects and grounds the antenna (fig. 2). Antenna relay K101 is also energized when the FUNCTION switch (S102 front) is in the CAL (through terminals 11 and 6) or STAND BY (through terminals 8 and 6) position, through terminals 5 and 4 of K101, to CR102.

27. Calibration Circuit. 100 Kc (fig. 27)

To calibrate the receiver at 100-kc intervals over its entire range, a calibration circuit consisting of calibration oscillator V205A, 100-kc multivibrator V206, and 100-kc cathode follower V205B are used. Crystal oscillator V205A generates a 200-kc signal to synchronize 100-kc multivibrator V206 which produces many 100-kc harmonics. This stage drives cathode follower V205B which, in turn, feeds the 100-kc markers to the control grid of rf amplifier V201.

a. Calibration oscillator V205A is a Pierce crystal oscillator. Resistor R220 is the dc grid return to ground and resistor R221 is the plate load resistor. Capacitor C312 at the plate of the calibration oscillator provides the feedback path to sustain oscillation. The 200-kc crystal (Y203) is connected between the control grid and the plate through capacitor C311. Crystal Y203 is kept at a constant temperature by crystal oven HR202. Trimmer capacitor C310 provides a means of making very small frequency adjustments. Capacitor C313 couples the 200-kc signal into the grid circuits of 100-kc multivibrator V206

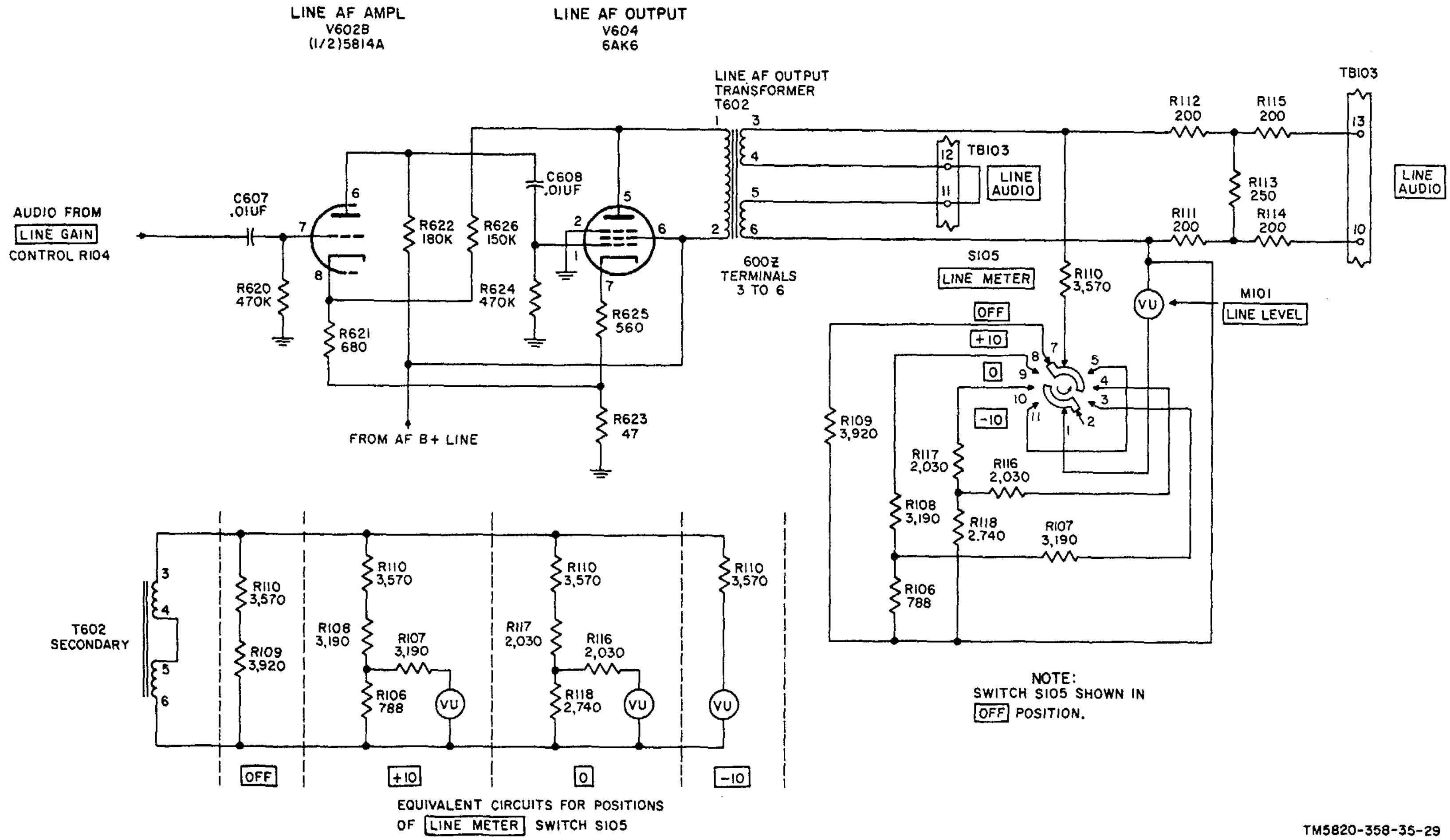


Figure 25, Line audio channel, simplified schematic diagram.

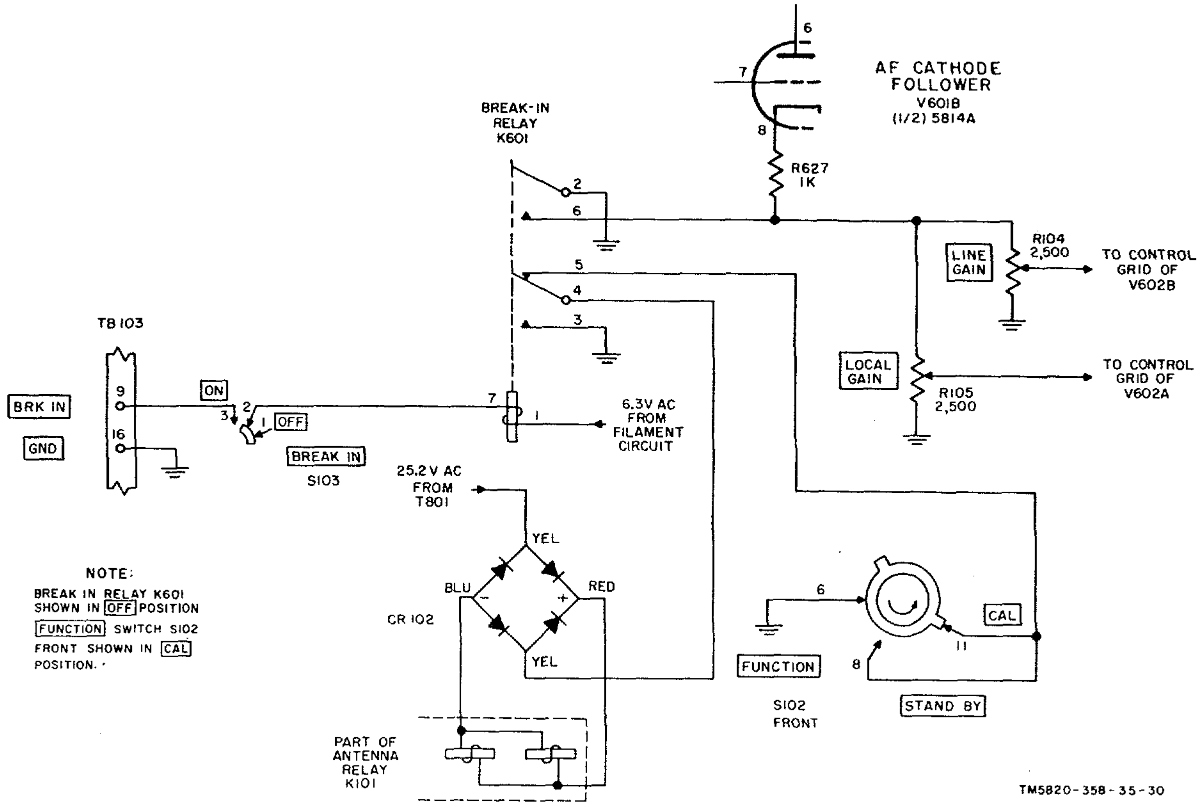


Figure 26. Break-in circuit, simplified schematic diagram.

at the junction of grid resistors R225 and R222 and common grid resistor R223.

b. Tube V206 is a multivibrator with the plate circuits of each section coupled to the grid circuits of the other section to sustain oscillation. The frequency of oscillation is chiefly controlled by the time constants determined by the values of grid resistors R222 and R225 and coupling capacitors C314 and C315. Resistors R224 and R226 are the plate load resistors for the plates of this twin triode. Capacitor C316, shunted by wave-shaping resistor R227, couples 100-kc harmonics to the grid of V205B. The output of V20'5B is developed across L210 and R229. Coil L210 resonates with circuit and output cable capacitance above 32 me, and provides high-frequency compensation to the 100-kc harmonics at the higher frequencies in order to maintain all of the 100-kc markers at approximately the same amplitude at the control grid of rf amplifier V201. Resistor R229 provides the load for the lower frequency harmonics and also prevents the stage from drawing excessive plate current. The 100-kc harmonics are fed through coaxial cable and the small 1-uuf coupling capacitor C228 to the control grid of rf amplifier V201. The plate of V205B is kept at rf ground potential through the decoupling network consisting of R228 and C320. When FUNCTION switch S102 is in the CAL position, plate voltage for all three stages is applied through rf filter choke L211, bypassed by C317.

28. Power Supply and Main Filter Circuits (fig. 28)

a. Power Supply. The primary windings of T801 may be connected for a 115or 230-volt ac power source (TM 11-5820-, 358-20). The 6.3-volt ac winding of T801 supplies power to break-in relay K6001,

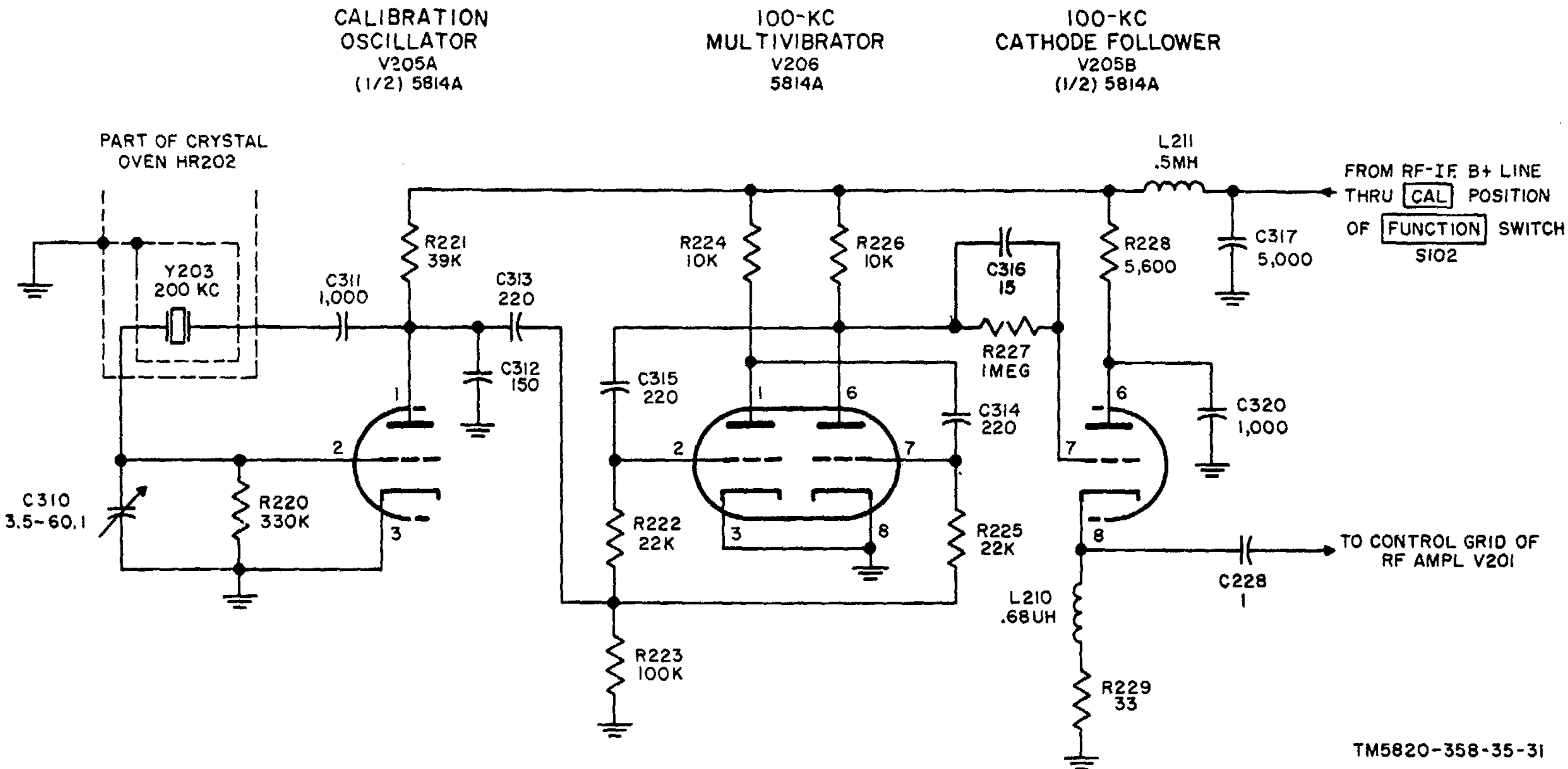


Figure 27. Calibration circuit, 100 kc, simplified schematic diagram.

oven heater HR202, and all filaments except V505 and V701. The 25.2-volt ac winding supplies power to the filaments of V801, V802, V505, and V701, and oven heaters HR401 and HR701. Plate and screen grid voltage for all the tubes in the receiver is also supplied by the power supply. The plates of each rectifier (V801 and V802) are connected in parallel and the combination of both tubes function as fullwave rectifier. The 570-volts ac developed by the center-tapped high-voltage winding of T801 is rectified by V801 andV802. The unfiltered dc voltage from the parallel cathodes of V801 and V802 is fed to terminal 1 of swinging choke L601.

b. Main Filter Circuits The B+ distribution follows three separate paths from the junction of terminal 2 of L601 and filter capacitor C606A. The first path is through filter choke L603 to the af B+ line where filter capacitor C603B supplies additional filtering. The s e c o n d path is through filter choke L602 to the rf-if. B+ line and filter capacitor C606B. The third path is through resistors R617, R618, and R619 to the + 150-volt regulated line and its test jack E607. Filter capacitor C603C supplies additional filtering to the +150-volt regulated line. A constant 150 volts is maintained between ground and the +150-volt regulated line by voltage regulator V605. The total resistance of R617, R618, and R619 supplies the series resistance required for proper regulating action of V605. Capacitor C611 bypasses noise generated by gas ionization in V605. Resistor R619 is shorted out of the circuit by contacts 7 and 8 of FUNCTION switch S102 rear in all positions except STAND BY.

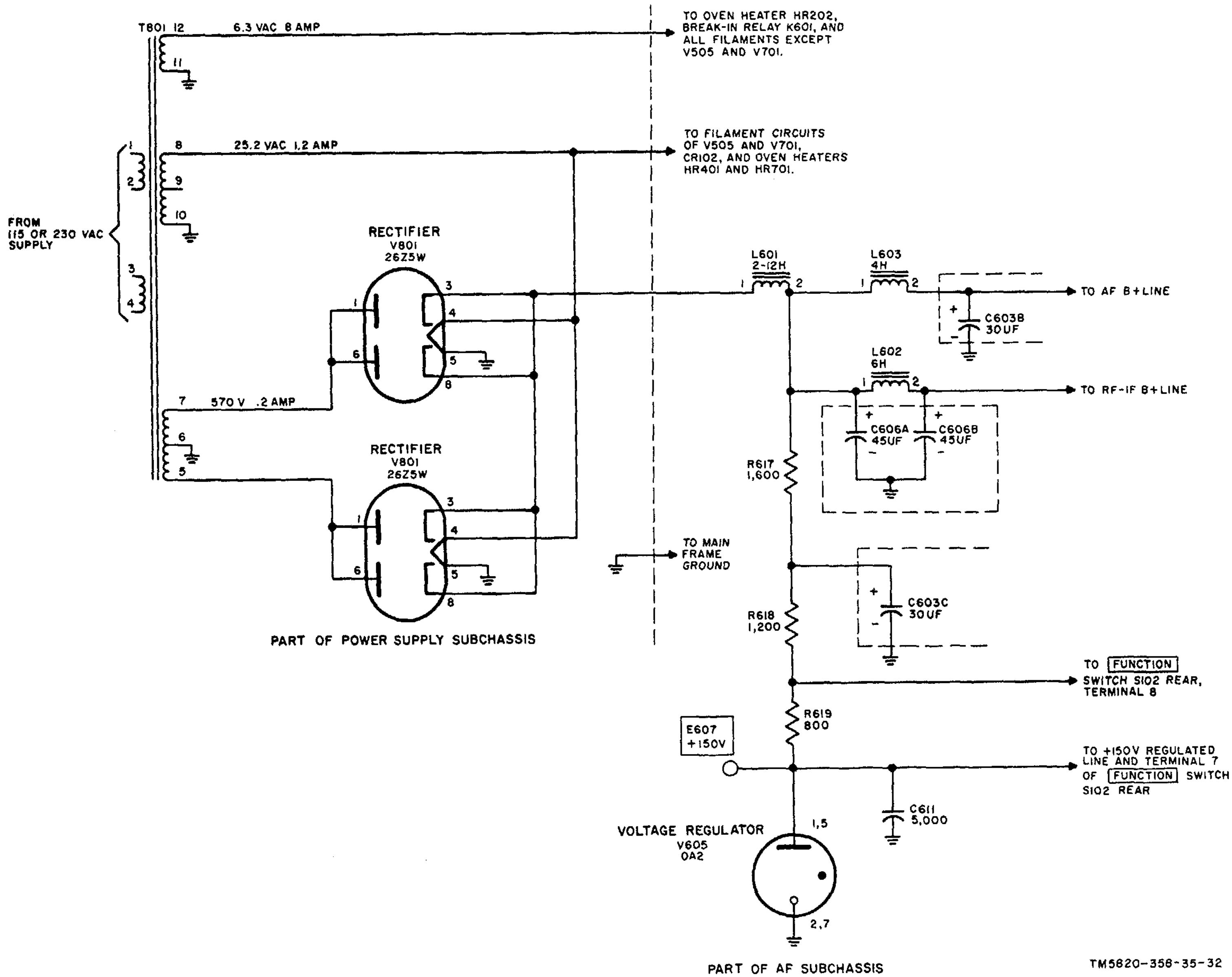


Figure 28. Power supply and main filter circuits, simplified schematic diagram.

29. General Principles of Operation (fig. 29)

a. General. The mechanical tuning system of Radio Receiver R-390A/URR controls the permeability tuning and switching to provide continuous linear tuning over a range of 0.5 to 32 me in 32 steps. Each step, or band of the MEGACYCLE CHANGE control (except the first band), is tuned linearly over a range of 1 me. The first band is tuned linearly from 0.5 to 1 me. Although the counter can be set between 00 000 and 00 500, no signal reception is possible within this range. The frequency to which the receiver is tuned is indicated on a counter-type dial, which indicates the frequency in kilocycles.

b. MEGACYCLE CHANGE Control. Operation of the MEGACYCLE CHANGE control is limited to 10 turns by a progressive mechanical stop. As the control is turned, the first two number wheels on the counter type dial are rotated, and the numbers coincide with the frequency of reception in thousands of kilocycles (megacycles) from 0 through 31. At the same time, the 32position crystal selector switch is switched to one of 32 positions. The rf band switches are also operated by this control through the intermittent gear and over travel coupler. This system operates the band switches at precisely the correct time as the MEGACYCLE CHANGE control is turned. The MEGACYCLE CHANGE control, through the differential, also controls the positioning of all slug racks except the 0.5- to 1-mc, 1- to 2-mc antenna and rf slug racks, and the second variable if. slug racks.

c. KILOCYCLE CHANGE Control. The KILOCYCLE CHANGE control is connected through a 10-turn stop to the vfo, the second variable if., the 1- to 2-mc and 0.5- to 1-mc antenna and rf slug racks. The KILOCYCLE CHANGE control knob is also connected through the same differential as the MEGACYCLE CHANGE control knob provides the movement for the 2- to 4-mc, 4- to 8-me, 8- to 16-mc, and the 16- to 32-mc antenna and rf slug racks and the first variable if. slug racks from the starting point established by the MEGACYCLE CHANGE control knob. A ZERO ADJ control knob on the front panel of the receiver allows frequency dial correction over a small range to align the frequency counter reading with the receiver frequency.

30. Functional Analysis (fig. 86)

a. General. A detailed study of the mechanical alignment, disassembly, and reassembly of the tuning assembly should be made in connection with the following analysis. To tune continuously from 0.5 to 32 me at a linear rate, not only must the correct coils and transformers be selected, but the slugs in them must be moved at the proper rate to tune them simultaneously. For example, to cover the 0.5- to 1-mc band, the slugs in coils T201 and Z201 move over their entire range, a distance of approximately eight-tenths of an inch. At the same time, the slugs in the coils of Z213 move approximately five-hundredths of an inch in covering this range. This tuning is controlled with a single knob moving numerous gears and cams.

b. KILOCYCLE CHANGE Control. Starting with the right-hand side of figure 86, it will be seen that the KILOCYCLE CHANGE control tunes the vfo directly through the 10-turn stop. Also connected to this control (broken lines) are the second variable if. slug rack (3 to 2 me) and the antenna and rf slug racks for the 0.5- to 1-mc and the 1 to 2-mc bands.

c. MEGACYCLE CHANGE Control. The 32 positions of crystal and tuned circuit switches S401 and S402 are selected (through the 10 turn stop) by the MEGACYCLE CHANGE control. The antenna, rf, and variable if. band switches, S201 through S208, are rotated through six positions (at exactly the right time) as the MEGACYCLE CHANGE control is turned through its full travel. This is accomplished through the intermittent gear and overtravel coupler. An intermittent gear turns its mating gear only when the few teeth of the driving gear mesh with the teeth of the driven gear. The MEGACYCLE CHANGE control also positions (through the differential) the starting points for the first variable if. (17.5- to 25-mc) and the antenna and rf coils for the 2- to 4-mc, 4- to 8-mc, 8- to 16-mc, and 16- to 32mc bands. From these starting points, the KILOCYCLE CHANGE control moves the slug racks (through the same differential) to cover the frequency range selected by the MEGACYCLE CHANGE control.

d. Shorting Adjacent Coils. The rear section of switch S204 (not shown in figure 86) short-circuits the secondary winding of the adjacent antenna transformer. This is necessary to prevent interaction with the secondary winding of the antenna transformer that has been selected by the front section of switch S204. The chart below indicates the secondary winding in use, and the secondary winding shorted by the rear section of S204.

Band switch position and frequency range (MC)	Secondary winding in use	Secondary winding shorted
1 (0.5-1)	L213	L217
2 (1-2)	L213	L215
3 (2-4)	L215	L217
4 (4-8)	L217	L219
5 (8-16)	L221	L219
6 (16-32)	L223	L221

e. Selection of Antenna Trimmer Capacitors. Either or both of antenna trimmer capacitors C225A and C225B are used for peaking the tuning of the secondary windings of antenna transformers T201 through T206 (para 6). The chart below indicates the band frequency range, the selection of C225A and/or C225B, and the use of parallel or series connection with a fixed capacitor across the selected antenna transformer secondary winding.

Band switch position and frequency range(MC)	C225A	C225B	Connection to fixed capacitor in antenna transformer
1 (0.5-1)	In	In	Parallel
2 (1-2)	In	In	Parallel
3 (2-4)	Out	In	Parallel
4 (4-8)	Out	In	Series
5(8-16)	In	Out	Parallel
6(16-32)	In	Out	Series

31. Detailed Mechanical Analysis (fig. 30)

a. General. The gears in figure 30 are identified by letter designations. The numbers indicate the number of teeth in each gear. The cams that furnish motion to the slug racks are shown as single units; actually, each slug rack has a roller at both ends and identical cams mounted on each end of the cam shaft.

b. MEGACYCLE CHANGE Control.

(1) As the MEGACYCLE CHANGE control is turned, it is limited to 10 turns by a 10-turn stop. The mc counter wheels show the frequency band or step selected by the MEGACYCLE CHANGE control. As this control is rotated, the counter wheels are driven through gears (A), (B), (C), (D), (E), (L), (M), (R), (S), and (T).

(2) The MEGACYCLE CHANGE control also operates the six-position rf band switch through gears (A), (B), (C), (D), (E), (F), (G), intermittent gear (H), and gears (J) and (K). T h e intermittent gear and over travel coupler provides an intermittent rotary motion so that the switch is turned to each one of its six positions at exactly the right time. Gear (G) rotates continuously as the MEGACYCLE CHANGE control is turned; however, gears (J) and (K) are driven only during the part of the rotation of gear (G) when the teeth of intermittent gear (H) engage the teeth of gear (J).

(3) Also operated by the MEGACYCLE CHANGE control is the 32-position crystal oscillator switch, This is accomplished through gears (A), (B), (C), (D), (E), (L), (M), (N), and (P).

(4) The 2- to 4-mc, 4- to 8-mc, 8- to 16-me, and 16- to 32-mc rf slug racks are moved by both the MEGACYCLE CHANGE and KILOCYCLE CHANGE controls through a differential gear system consisting of gears (NN), (B), (WW), and (U).

(*a*) The 2- to 4-mc rf slug rack is operated by the

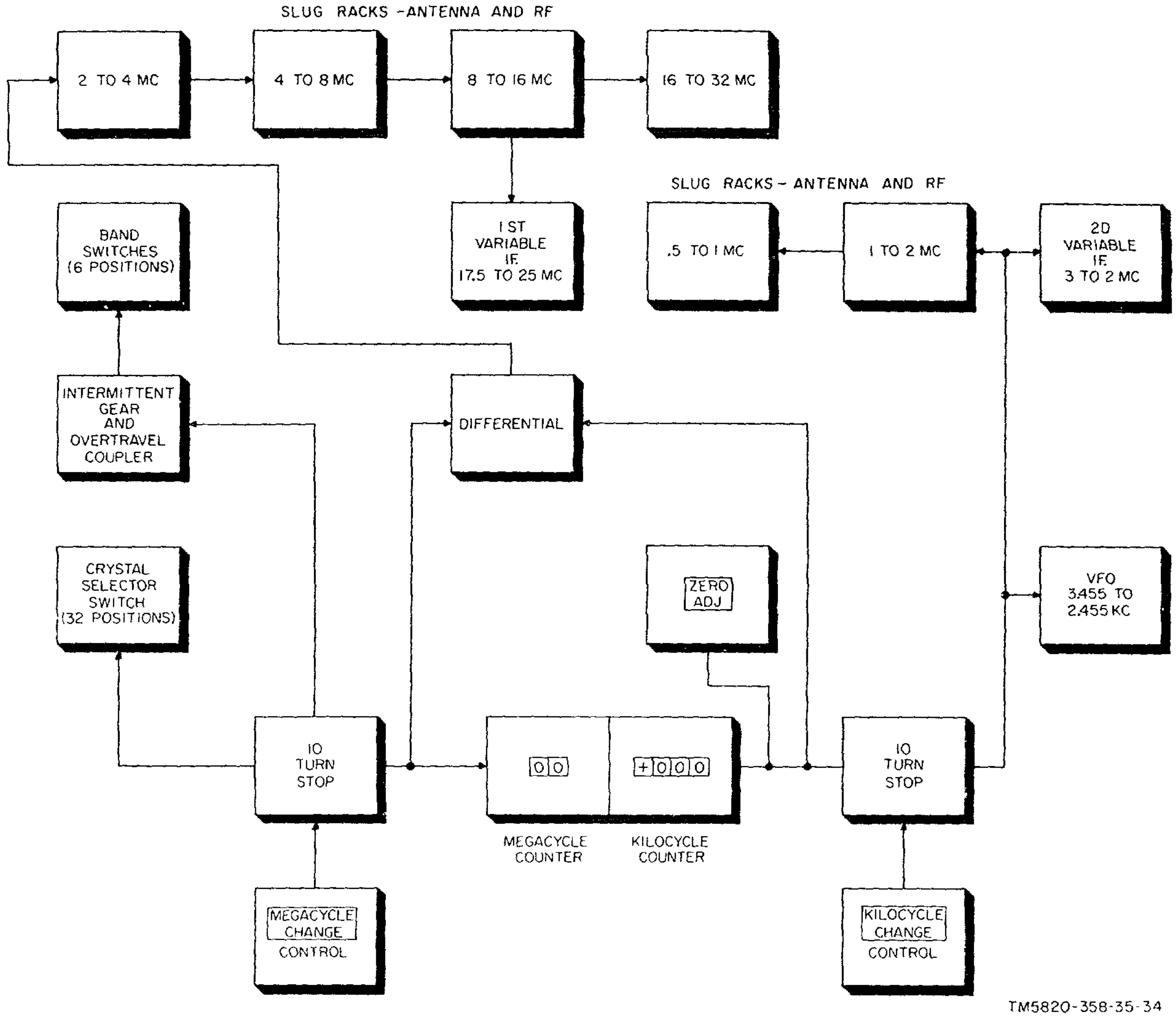


Figure 29. Tuning system, mechanical, block diagram.

MEGACYCLE CHANGE control through gears (A), (B), (U), (V), (W), and (X).

(b) The 4- to 8-me rf slug rack is operated by the MEGACYCLE CHANGE control through gears (A), (B), (U), (V), (W), (X), (Y), and (Z).

(c) The 8- to 16-me rf slug rack is operated by the MEGACYCLE CHANGE control through gears (A), (B), (U), (V), (W), (X), (Y), (Z), (AA), and (BB).

(d) The 16- to 32-mc rf slug rack is operated by the MEGACYCLE CHANGE control through gears (A), (B), (U), (V), (W), (X), (Y), (Z), (AA), (BB), (CC), and (DD).

(5) In each of the steps (bands 0.5-1 through 16-32 mc), it is necessary to have an exact stopping point or reference for the circuit elements controlled by the MEGACYCLE CHANGE control. This is done by the mc change detent. A disk with three equally spaced notches around its edge touches the me change detent and locks the disk when the mc change detent falls into one of the three notches. This

mc change detent is made of spring material, and constantly maintains pressure against the three-notch disk.

(6) The first variable if. slug rack (17.5 to 25 mc) is driven by the MEGACYCLE CHANGE control in the same manner and on the same shaft as the 8- to 16-mc rf slug rack. The gearing is through gears (A), (B), (U), (V), (W), (X), (Y), (Z), (AA), and (BB).

c. KILOCYCLE CHANGE Control.

(1) The KILOCYCLE CHANGE control is limited to 10 turns by a 10-turn stop. The kc counter wheels show the frequency selected by the KILOCYCLE CHANGE control. To permit overlapping of each band selected, the frequency range of this control is slightly greater than 1 mc. As the KILOCYCLE CHANGE control is rotated, the kilocycle counter wheels are driven through gears (EE), (FF), (GG), (HH), (JJ), and (KK).

(2) The vfo tuning unit is connected to the KILOCYCLE CHANGE control through the 10-turn stop and the Oldham coupler. The Oldham coupler is a coupling device for correcting slight misalignment of two shafts.

(3) The 0.5 to 1-mc rf slug rack cam is operated by the KILOCYCLE CHANGE control through gears (EE), (FF), (LL), (MM), (NN), (PP), (RR), and (SS). The 1- to 2-mc rf slug rack cam is operated through gears (EE), (FF), (LL), (MM), (NN), (PP), (RR), (SS), (TT), and (UU).

(4) The second variable if. slug rack cam (3 to 2 mc) is operated by the KILOCYCLE CHANGE control through the same gears and same shaft as the 1- to 2-mc rf slug rack cam.

(5) The 2- to 4-mc, 4- to 8-mc, 8- to 16-mc, 16- to 32-mc rf slug rack cams are moved by the KILOCYCLE CHANGE control through a differential gear system. These rf slug rack cams are operated through the same gears as in *b*(4)(*a*) through (d) above, except for gears (A) and (B). Gears (EE), (FF), (LL), (MM), (NN), (VV), and (WW) are used instead of gears (A) and (B).

d. ZERO ADJ Control. The ZERO ADJ control provides for correcting errors in calibration. A locking screw operated by the knob releases the clutch and locks the gear (GG). Tuning over a range of approximately 15 kc without moving the setting on the three kilocycle counter wheels on the frequency indicator is possible with the KILOCYCLE CHANGE control. Operation of the ZERO ADJ knob in a counterclockwise direction engages the clutch and unlocks gear (CG).

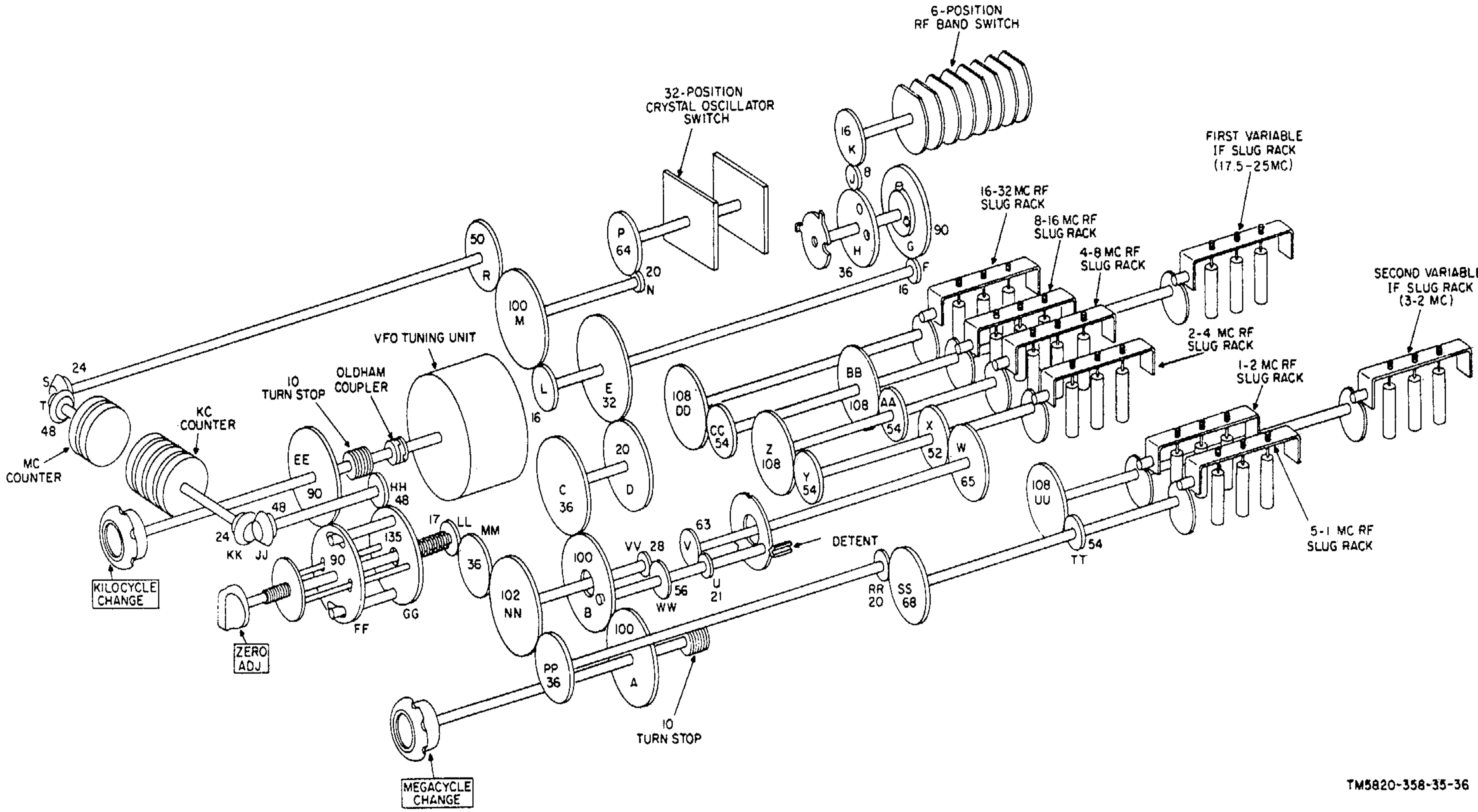


Figure 30. Tuning system, simplified mechanical diagram.

Section I. GENERAL TROUBLESHOOTING TECHNIQUES

Warning: **When servicing the receiver, avoid contact with the power supply and plate circuits. The high voltages present in these circuits can cause serious injury or death. Connect GND terminal 16 to the same ground as the ac power source before applying power to the receiver.**

32. General

Third echelon maintenance procedures in this manual supplement the procedures described in the organizational maintenance manual. Systematic troubleshooting procedure begins with the operational and equipment performance checks that can be performed at organizational level (TM 11-5820-358-20). This chapter describes more advanced techniques to sectionalize, localize, and isolate defects in the receiver.

33. Organization of Troubleshooting Procedures

a. General. When troubleshooting the receiver, begin at the output circuits and work back toward the antenna circuits. The first step in servicing a defective receiver is to sectionalize the fault. Sectionalization means tracing the fault to the subchassis responsible for the abnormal operation of the receiver or to the main frame. The second step is to localize the fault. Localization means tracing the fault to a defective circuit on a subchassis or to the parts and wiring of the front panel or main frame. Finally, isolate the trouble to a defective part by use of voltage, resistance, and continuity measurements. Some faults, such as burned-out-resistors, shorted transformers, and loose connections often can be located by sight, smell, hearing; however, the majority of faults must be located by checking tubes, voltage, and resistance.

b. Detailed Procedure. The tests listed below are to be used as a guide in isolating the source of the trouble. Follow the procedure in the order given. The procedure is summarized in (1) through (8) below, which contain references to paragraphs having detailed information for carrying out the tests.

(1) *Visual inspection.* Make a visual inspection to locate troubles within a receiver by inspecting the condition of the wiring and individual parts for visible signs of failure. The visual inspection (para 40) can be quickly and easily made and is capable of producing rapid results.

(2) *Checking B+ and filament circuits for shorts.* When the trouble is unknown, always check the B+ and filament for shorts (para 41 and 42) before applying power to the receiver.

(3) *Equipment performance checks.* Use the information gained by performing the equipment performance checks (TM 11-5820-358-20). It is often possible to determine the exact fault by these checks.

(4) *Overall receiver gain test.* If the result of the overall receiver gain test (para 45) is normal, the trouble is in the audio frequency portion of the receiver. If the result is abnormal, the trouble is in the rf, if., or detection portion of the receiver.

(5) *High-frequency oscillators injection voltage tests.* Check the operation of the high-frequency oscillators (para 44) in the receiver.

(6) *Troubleshooting chart.* Use the troubleshooting chart (para 46) to

systematically troubleshoot the receiver.

(7) *Voltage and resistance measurements.* Use the resistor and capacitor color codes (fig. 83 and 84) to find the value of components. Use the voltage and resistance diagrams (fig. 58 through 64) to isolate the trouble to a part. Compare the normal readings given in these diagrams with the readings taken.

(8) *Signal substitution.* Use signal substitution (para 47) to track down trouble to a stage.

(9) *Intermittent troubles.* In all these tests, the possibility of intermittents should not be overlooked. If present, this type of trouble may often be made to appear by tapping or jarring the subchassis, tubes, or parts under test. It is possible that the trouble is not in the receiver itself, but in the installation. In this event, substitute a receiver known to be operating normally. Cover the receiver to cause its operating temperature to rise. This sometimes causes intermittent troubles to appear more readily.

34. Test Equipment for Third Echelon Troubleshooting

The following chart lists the test equipment and the associated technical manuals required for third echelon troubleshooting of the receiver.

Test equipment	Technical manual
Accessory Kit MX-288/URM	
Adapter, Test MX-1487/URM-25D or Impedance Matching Network CU-406/URM-25F	
Audio Oscillator TS-382(*)/U[a]	TM 11-2684
Electron Tube Test Set TV- 7(*)/U[b]	TM 11-6625-274-12
Electronic Multimeter TS-505(*)/U[c]	TM 11-5511 and TM 11-6625-239-12
Frequency Meter AN/URM-32(*)[d]	TM 11-6625-320-12
Loudspeaker LS-3	
Multimeter AN/URM-105	TM 11-6625-203-12
Multimeter TS-352/U(*)[e]	TM 11-5527
Rf Signal Generator Set AN/URM-25(*)[f]	TM 11-5551D or TM 11-5551E
Voltmeter, Meter ME-30(*)/U[g]	TM 11-6625-320-12

[a]Indicates TS-382A/U, TS-382B/U, TS-382D/U, and TS-382E/U.
[b]Indicates TV-7A/U and TV-7B/U.
[c]Indicates TS-505/U and TS-505A/U through TS-505D/U.
[d]Indicates AN-URM-32 and AN/URM-32A.
[e]Indicates TS-352/U, TS-352A/U, and TS-352B/U.
[f]indicates AN/URM-25D or AN/URM-25F.
[g]Indicates ME-30A/U and ME-30B/U.

Section II. TROUBLESHOOTING RECEIVER

***Caution:* Do not attempt removal or replacement of parts or subchassis before reading the instructions in paragraphs 57 through 65.**

35. Test Cable Data
(fig. 31 and 32)

Test cables are required when operating subchassis out of the receiver. Make all cables 24 inches long. The following chart lists the plug, jack, destination, and connector Federal stock number for each test cable required.

Coaxial test cables					
From plug No.	Fig. No.	Federal stock No.	To jack No.	Fig. No.	Federal stock No.
P717	36	5935-204-6390	J217	43	5935-204-6404
P215	43	5935-204-6390	J415	46	5935-204-6404
P207	43	5935-204-6390	J107	55	5935-204-6404
P206	43	5935-204-6390	J106	55	5935-204-6404
P205	43	5935-204-6390	J105	55	5935-204-6404
P218	43	5935-204-6391	J518	40	5935-642-3122
P213	43	5935-204-6391	J513	40	5935-642-3122

Multiconductor test cables					
From plug No.	Fig. No.	Federal stock No.	To jack No.	Fig. No.	Federal stock No.
P108	36	5935-257-8683	J208	43	5835-201-2449
P109	37	5935-257-8683	J709	49	5835-201-2449
P110	36	5935-258-8170	J410	46	5935-636-5913
P111	37	5935-258-8356	J811	54	5935-259-6798
P112	36	5935-258-9142	J512	39	5935-173-5408
P119	37	5935-258-8356	J619	51	5935-259-6798
P120	37	5935-351-3797	J620	51	5935-295-5006

36. Initial Control Settings

Use the control settings given below before performing any test or troubleshooting procedure. Many of the tests that follow repeat some of the settings and others refer back to this paragraph to stress the importance of using the proper control settings. Observe these control settings, and change them *only when instructions in a particular procedure direct different control settings.*

LINE METER	OFF
LINE GAIN	0
AGC	MED
LIMITER	OFF
AUDIO RESPONSE............	WIDE
BANDWIDTH	8
BFO PITCH.........................	O
BREAK IN...........................	OFF
FUNCTION	AGC
ANT TRIM...........................	0, or maximum output
BFO	OFF
DIAL LOCK	Unlocked, fully counterclockwise
ZERO ADJ..........................	Disengaged, fully counterclockwise
LOCAL GAIN	5, or desired volume
OVENS................................	OFF
MEGACYCLE CHANGE 01, or as specified	
KILOCYCLE CHANGE . 510, or as specified	
RF GAIN	10

37. Bench Testing

a. When testing or troubleshooting the receiver, do not remove a subchassis unless it is absolutely necessary. Test cables are required for operating a subchassis out of the receiver (para 35). If a receiver in good operating condition is available, a subchassis may be connected from it, directly into the receiver being repaired.

b. To prepare a subchassis for testing or troubleshooting outside the receiver main frame, follow the instructions given in paragraph 57. *Avoid disturbing the synchronization of the rf gear train assembly with the rf, crystal oscillator, or vfo subchassis.*

c. Figure 33 shows the numbers of the terminals on the rf and the variable if. coils as seen from the bottom of the rf subchassis. These numbers are used to identify the terminals in the schematic diagrams in this manual.

38. General Precautions

a. When the receiver is removed from the case, cabinet, or rack for servicing, connect a suitable ground to the main frame and to any subchassis operated outside the main frame, before connecting the power cord.

b. Be sure that the receiver is disconnected from the power source or is turned off before touching high-voltage circuits or changing connections.

c. After disconnecting auxiliary equipment and before testing the receiver, check to see that the jumpers on the rear panel terminal boards are installed as shown in TM 11-5820-358-10.

d. After disconnecting the tuning shafts for removal of a subchassis, avoid turning the shafts or tuning control unless necessary for troubleshooting or adjustment. Careful handling may eliminate the

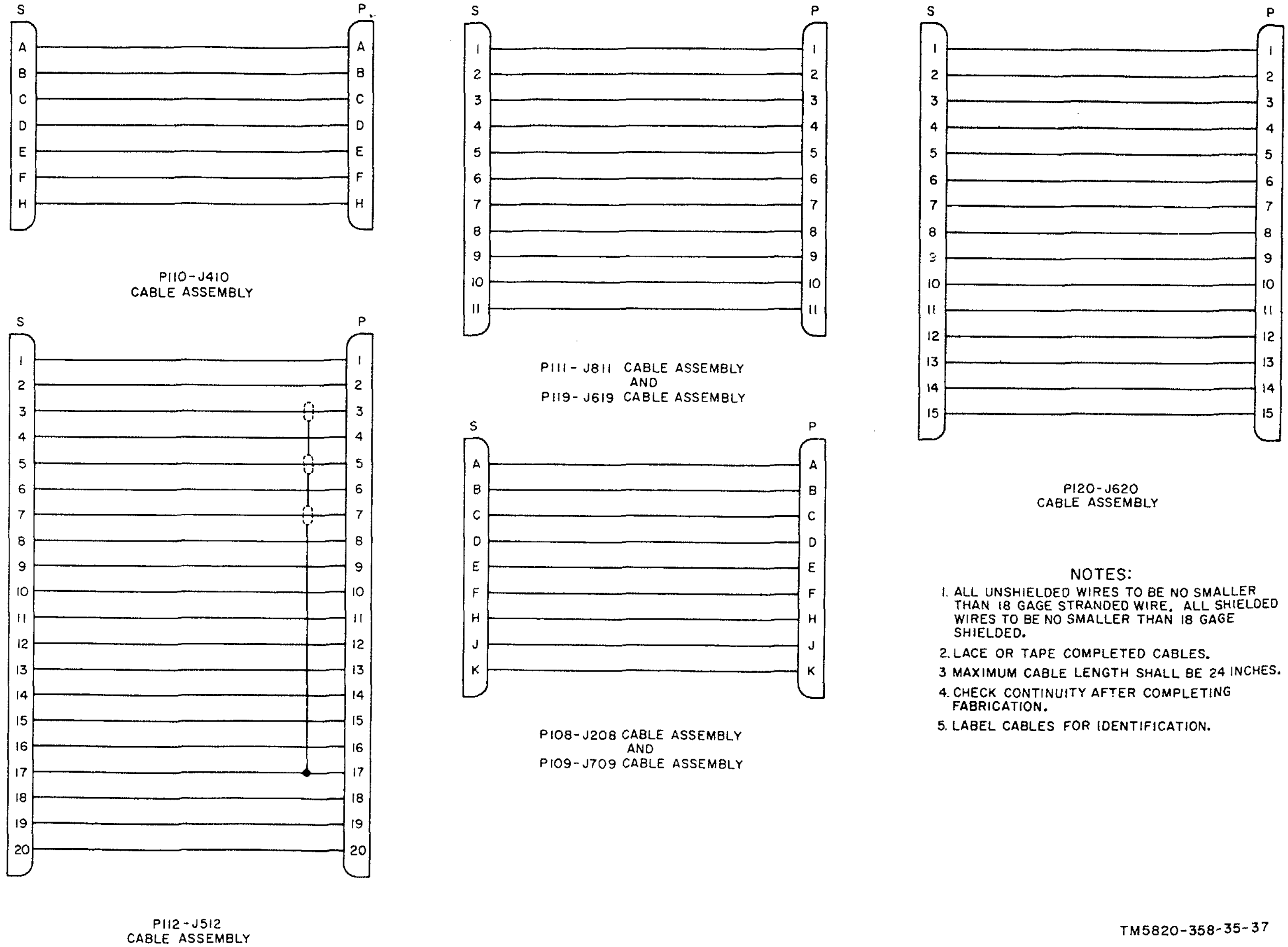


Figure 31. Fabrication of multiconductor test cables.

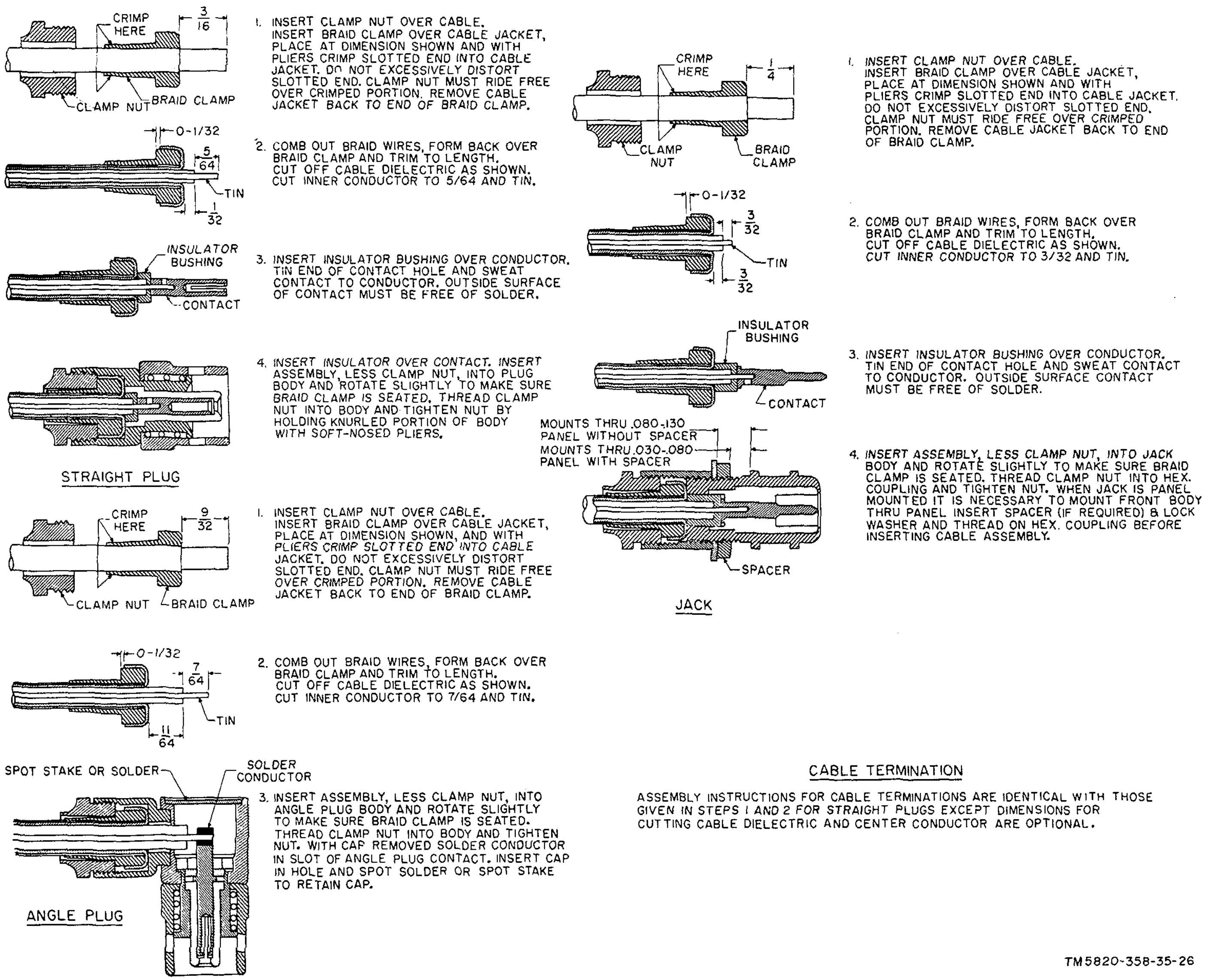


Figure 32. Fabrication of coaxial test cables.

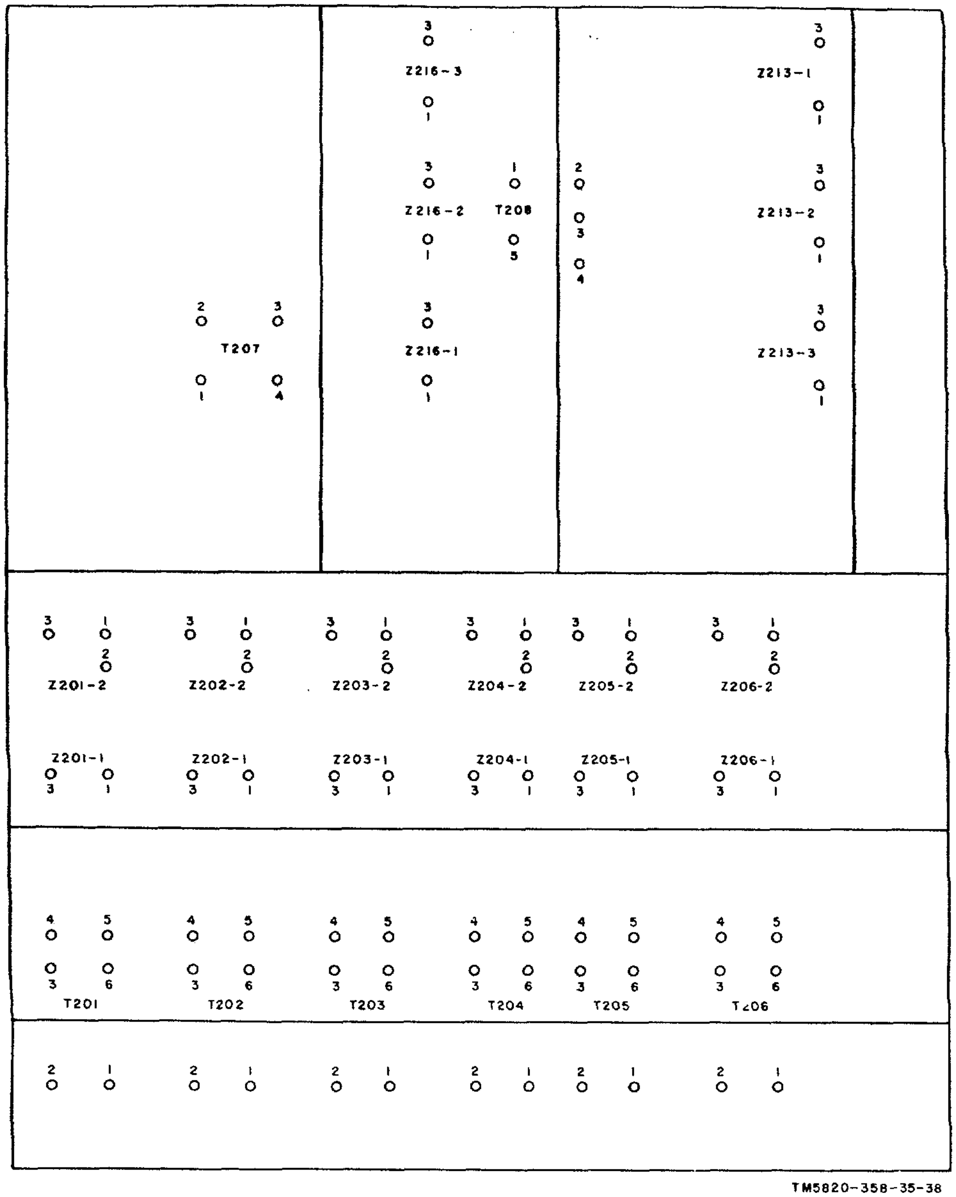


Figure 33. Terminal numbers of rf and variable if. Coil

need for mechanical synchronization. Make a note of the positions of the front-panel controls indicated in the removal procedure when removing a subchassis; a control may be accidentally disturbed during servicing.

e. Careless replacement of parts often makes new faults.

(1) Before unsoldering a part, note the position of the leads. If the part has a number of connections, tag each of its leads, or make a sketch of the proper connections.

(2) Be careful not to damage leads while pulling or pushing them out of the way.

(3) Do not allow drops of solder to fall into the receiver; they may cause short circuits.

(4) A carelessly soldered connection may create a new fault. It is important to make well-soldered joints; a poorly soldered joint is one of the most difficult faults to find.

(5) When a part is replaced in the rf

or if. circuits, place it in the exact position of the original part. A part that has the same electrical value but different physical size may cause trouble in high-frequency circuits. Give particular attention to proper grounding when replacing a part. Use the same ground connection as in the original wiring. Failure to do so may result in decreased gain or undersired oscillation.

f. Before making voltage measurements or performing signal tracing, always check the value of the regulated dc voltage, unregulated dc voltage, and ac line voltage. Approximately +150 volts do should be obtained at the +150-volt dc jack, E607 (fig. 51), located on the af subchassis. This jack is accessible through the main frame of the receiver, at the left side. Check the unregulated dc voltage at pin 6 of XV603. Remove tube V603 (fig. 51) from its tube socket for access to pin 6. This voltage should be between 200 and 225 volts positive with respect to chassis ground when the receiver is operating.

39. Detailed Troubleshooting Techniques

a. To avoid removing a subchassis when voltage is to be measured or when a signal is to be injected at a tube-socket pin that does not have a test point, remove the tube, wrap a short length of thin insulated wire (both ends bared), around the desired tube pin. A more convenient method is the use of a tube adapter with test points. Construction information is shown in figure 34. The rf tuning coils and transformers on the rf subchassis can be removed readily (para 63c), if necessary, to permit measurement of voltage or resistance at the socket contacts, or measurement of the continuity of the coils.

b. If trouble is suspected in the rf subchassis, perform as much detailed troubleshooting as possible before removing it to be sure that the trouble is in the subchassis. Removal and replacement of the rf subchassis is time-consuming.

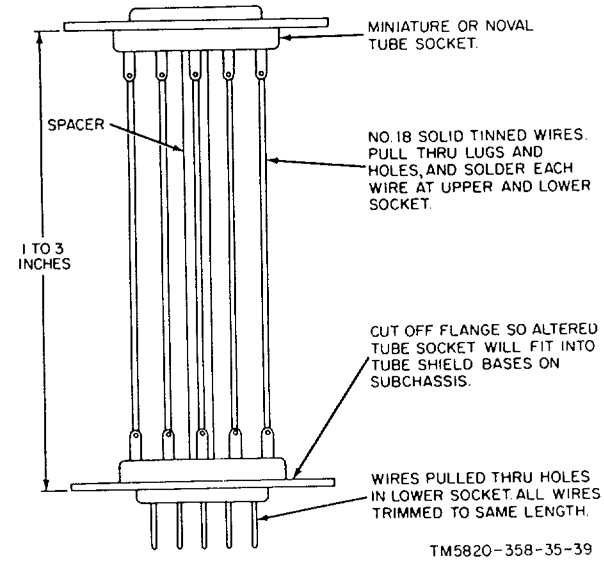


Figure 34. Fabrication of tube test point adapters.

c. A test-speaker assembly (fig. 35) is useful when testing or troubleshooting the Figure 34. Fabrication of tube test point adapters. receiver. Connect the spade lugs to the LOCAL AUDIO or LINE AUDIO terminals on the rear panel of the receiver. The three-position, two-section rotary switch can be adjusted to an OFF position, a SPEAKER position, or a 600 OHM LOAD position. The external terminal board provides tie points for the ME-30/U. The test-speaker assembly can be made from general-purpose parts. The only critical item is the 600-ohm, noninductive resistor. Use a 2-watt carbon resistor with a tolerance of ±5 percent.

d. Receiver noise can be extremely useful in troubleshooting. A properly operating receiver will produce considerable noise when the rf and af gain controls are advanced fully clockwise. Use the supplementary equipment performance checklist information (TM 11-5820-358-20).

e. The CARRIER LEVEL meter and the LINE LEVEL meter on the receiver are used for testing and troubleshooting. The CARRIER LEVEL meter measures the relative signal strength of the in coming rf or test signals. Indications on this meter are proportional to those at the AGC terminals on the rear panel of the receiver. The LINE LEVEL meter readings can be translated into audio output or power ratio readings. The LINE METER switch extends the range of the LINE LEVEL meter over a 40-db range.

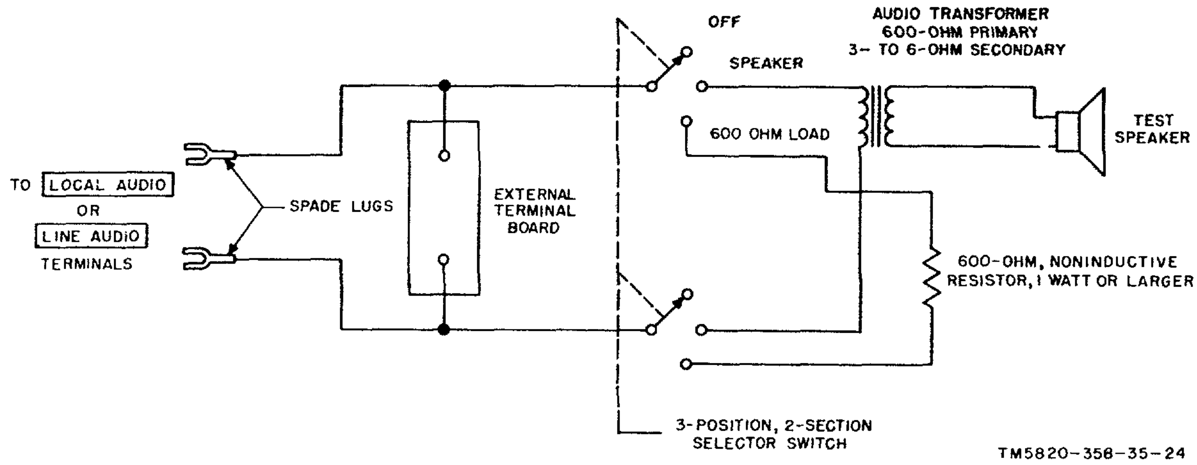


Figure 35. Test-speaker assembly fabrication.

40. Visual Inspection

When a receiver is brought in from the field for a check or repair, remove the top and bottom dust covers, and inspect it according to the instructions in a through g below. Observe the precautions described in paragraph 38.

a. Inspect all cables, plugs, and receptacles. Check to see that all connectors are seated properly. Improperly seated connectors are a frequent cause of abnormal operation in equipment. Repair or replace any connectors or cables that are broken or defective.

b. Inspect for burned insulation and resistors that show signs of overheating. Look for wax leakage and any discoloration of parts and wires.

c. Inspect for broken connections to tube sockets, plugs, and other parts, as well as for defective soldered connections. Examine for bare wires touching the chassis or adjoining wires.

d. Be sure that all tubes are in their correct positions (TM 11-5820-358-20). Replace or interchange any tubes that are not of the type called for in the illustrations. If any 6C4W tubes are being used in the receiver, replace them with type 6C4 or 6C4WA. Replace broken tubes. Inspect for loose tube-socket contacts.

e. Inspect the AC 3 AMP fuse and replace, if necessary (TM 11-5820-358-10). Check carefully for short circuits (para 58 41 and 42) whenever a blown fuse is found. Receivers bearing Order No. 14-Phila-57, serial numbers 2683 and above, and Order No. 14385-Phila-58, have a 1/4-ampere and a 1/8-ampere B+ fuse on the rear panel in addition to the AC3 AMP fuse; inspect these fuses.

f. Be sure that the MEGACYCLE CHANGE and KILOCYCLE CHANGE controls turn freely. Rough operation or binding indicates a damaged tuning system or the need for cleaning and lubrication (TM 11-5820-358-20).

g. Check all switches and controls for ease of operation.

41. Checking B+ Circuits for Shorts (fig. 89)

a. To prevent damage to a receiver sent in for repair, unless the trouble is known, always check the high-voltage circuits for shorts. A B+ short will blow AC 3 AMP fuse F101, damage rectifiers V801 and V802, cause resistors to burn up, or cause any combination of these damages. Receivers bearing Order No. 14-Phila-56, serial numbers 2683 and above all on Order No. 14385-Phila-58, have a 1/4ampere and a 1/8-ampere B+ fuse on the rear panel. A B+ short in these receivers will blow either 1/4-ampere fuse F102 or 1/8-ampere fuse F103.

b. To prepare the receiver for the B+ short circuit resistance measurement

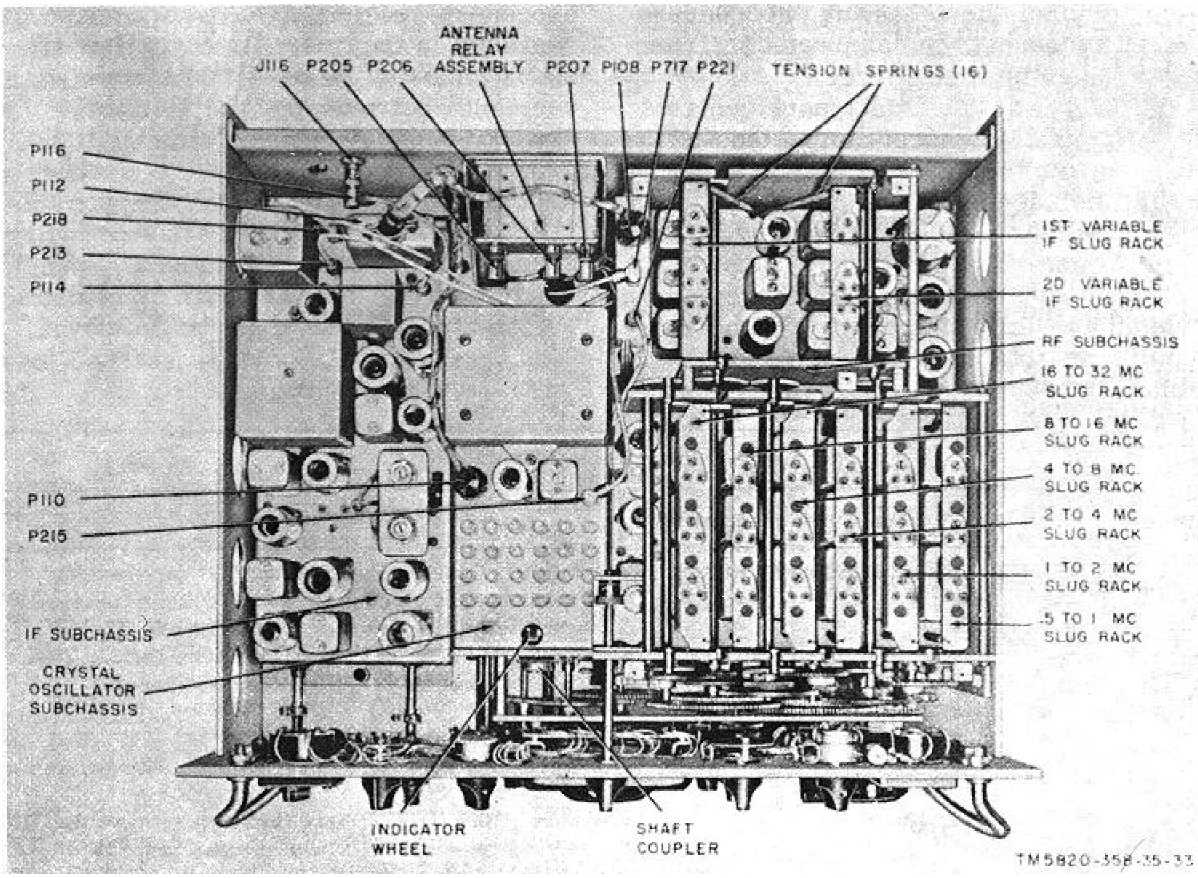


Figure 36. Radio Receiver R-390A/URR, top view.

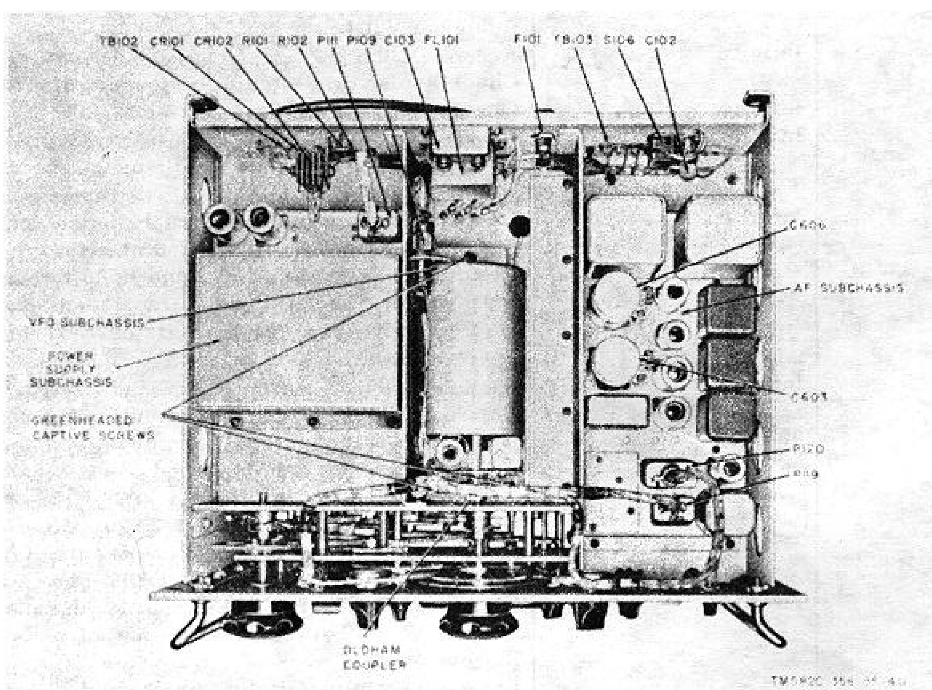


Figure 37. Radio Receiver R-390A/URR, bottom view.

tests, perform the following procedures.

(1) Disconnect the ac power plug from the ac power source.

(2) Adjust the front panel controls (para 36) except turn the BFO switch to ON.

(3) Replace any blown fuses.

(4) Set the receiver frequency below 8 mc.

c. Make the resistance measurements listed in the following chart. If abnormal results are obtained, make the additional isolating checks listed in the isolating procedure column. Always proceed to the next step in the order listed until the trouble is isolated. Make all resistance measurements between the point listed in the *Point of measurement* column and chassis ground. To detect a shorted tube, observe the ohmmeter while removing each tube. If a tube is shorted, the resistance will increase as the tube is removed. When the faulty part is found, repair or replace it before applying power to the receiver.

Note: The tube location illustrations are in TM 11-5820-358-20.

B+ Short-circuit tests

Point of measurement	Normal indication (ohms)	Isolating procedure
Pin 3 of V801	Not less than 15,000	Infinite Remove V801. Connect the TS-352(*)/U between pin 3 of V801 and chassis ground. Proceed with the tests only if the indication is less than 15,000 ohms.
J811-5	Infinite	Disconnect P111 (fig. 37) from J811. Connect the TS-352(*)/U between J811-5 and chassis ground. Remove V802. Remove power-supply subchassis (TM 11-5820-358-20) and check tube sockets XV801, XC802, and wiring for grounds
J208-A	92,000	Disconnect P108 (fig. 36) from J208 and connect the TS-352(*)/U between J208-A and chassis ground. Remove V201 through V204. Remove the rf subchassis (para 59). Check plate circuit components of V201 through V204.
J208-D	Infinite	Remove V207. Check plate and screen circuit components of V207.
J208-K	Infinite	Check screen grid circuit components of V207.
J208-J	Infinite	Remove V205 and V206. Check plate and screen grid circuit components of V205 and V206.
J512-2	Infinite	Disconnect P112 (fig. 36) from J512 and connect the TS-352(*)/U between J512-2 and chassis ground. Remove V501 through V504, and V506 through V509. Remove the if. subchassis (para 61), and check plate and screen crid circuit components of V501 through V504, and V50(i through V509.
J512-11	Infinite	Remove V505. Check plate and screen grid circuit components of V505
J619-5	90,000	Disconnect P119 (fig. 37) from J619, and connect the TS-352(*)/U between J619-5 and chassis ground. Remove V601 through V605. Remove af subchassis (TM 11-5820-358-20). Check plate and screen grid components of V601 through V605. Be sure to test C603, C606, and C611.
J410-A	Infinite	Disconnect P110 (fig. 36) from J410, and connect the TS-352(*)/U between J410-A and chassis ground. Remove V401. Remove crystal-oscillator subchassis (para 60). Check plate circuit components of V401.

B+ Short-circuit tests		
Point of measurement	**Normal indication (ohms)**	**Isolating procedure**
J410-C	Infinite	Check screen grid circuit components of V401.
J709-A	Infinite	Disconnect P109 (fig. 37) from J709A, and connect the TS-352(*)/U between J709A and chassis ground Remove V701. *Caution:* If V701 is not defective, be sure to replace the same tube in XV701. If V701 must be replaced by a new tube, make the end point adjustment (para 81). Remove vfo subchassis (para 65) and check plate circuit components of V701. Check screen grid circuit components of V701.
J709-B J619-2, J619-3 J619-4, andJ619-5	Infinite Not less than 15,000	Disconnect P119 from J619, and check between the points listed in the point of measurement column and chassis ground. Remove the af subchassis (TM 11-5820-358-20). Check the main filter and voltage regulator circuit components. Be sure to check C606, C603C, and C611

d. If the fault cannot be isolated by the tests in c above, the trouble is in the mainframe wiring. Use the main-frame wiring diagram (fig. 87) in conjunction with the main-frame and continuity chart (para 55). Paragraph 56 lists the resistance measurements between chassis ground and the subchassis power connector terminals. Shorts and opens may often be detected by making the measurements listed.

e. In some cases, B+ shorts will be intermittent or will appear only when B+ voltage is present. If this is the case, disconnect all power connectors except power-supply subchassis connector Pill and af subchassis connector P119. Apply power by connecting 115 volts ac (or 230 volts ac if power transformer T801 primary is connected for 230 volts ac) and setting the FUNCTION switch to AGC. Remove tube V603 from the af subchassis and connect the TS-352(*)/U to pin 6 of XV603. If the voltage is approximately 215 to 240 volts, the B+ short is not in the af subchassis.

f. Reconnect each subchassis, one at a time; each time, note the B+ voltage at pin 6 of XV603. Each time an additional subchassis is reconnected, B+ voltage will drop a few volts after the tubes warm up, This is normal, because of the additional load.

g. When the if. subchassis is tested in this manner, momentarily turn the BFO switch to ON to check the bfo circuit for B+ shorts.

h. When the rf subchassis is tested, check the calibration oscillator by momentarily setting the FUNCTION switch to CAL. Tune the receiver to a frequency between 0.5 mc and 8 mc. This applies regulated +150 volts to the screen grid of V207.

i. When reconnecting the crystal-oscillator subchassis and the vfo subchasis, check the regulated voltage at +150-volt test point E607 (fig. 51). This point can be reached through an access hole at the left side of the receiver. Check for approximately 205 to 225 volts on pin 6 of XV603 when all the subchassis are reconnected.

42. Checking Filament and Oven Circuits for Opens and Shorts (fig. 90)

a. Open Circuits.

(1) An open circuit in the filament and/ or oven circuits will not cause damage to the receiver, but will render the receiver, or some of its functions, inoperative. All tube filaments are connected in parallel with the ac 6.3-volt filament winding of power transformer T801 with the exception of V505, V701, V801, and V802. The filaments of V505 and V701 are connected in series with current-regulator tube RT510,

which is located on the if. subchassis. A tube that does not light either has an open filament or the circuit carrying the filament power is open. A tube with an open filament is easily detected by substituting a tube known to be good.

Note: **When reinserting tubes, put the original tube back in XV701 or the receiver will need realignment.**

(2) If tubes V505 and V701 do not light, the trouble is with either tube, current-regulator tube RT510, or in the wiring of the series circuit. If rectifiers V801 and V802 do not light, the trouble is with the tubes, an open 25.2-volt ac filament winding on power transformer T801, or in the power-supply subchassis wiring.

(3) Crystal oven HR202 on the rf subchassis is always connected to the 6.3-volt ac line. If HR202 does not operate, the thermostat switch, the heater winding, or the wiring to it is defective. For vfo oven HR701, or crystal-oscillator oven HR401 to operate, OVENS switch S106 must be in the ON position. Trouble in these circuits must be detected by checking the individual parts in each one.

b. Short Circuits.

(1) Short circuits in the tube heater and/or oven circuits usually blow the AC 3 AMP fuse on the rear panel on the receiver. Disconnect all power/plugs except Pill (fig. 37) from the power-supply subchassis and apply ac power to the receiver. Turn the FUNCTION switch to STAND BY. If tubes V801 and V802 in the power-supply subchassis light and fuse F101 does not blow, the trouble is in one of the other subchassis. If the fuse blows, the trouble is in the power-supply subchassis or main-frame wiring. Follow the procedure in (2) below for locating the tube filament or oven short.

(2) Remove all tubes and the power plug from the subchassis to be tested. Check between the terminals listed in the chart below and ground, unless otherwise specified. If the resistance value is below that specified, a filament bypass capacitor or an oven heater winding is short-circuited.

Subchassis	Points of ohmmeter check	Resistance not less than
Rf subchassis	J208-B J208-F	Infinity 100 ohms
If. subchassis	J512-8 J512-19 J512-20	Infinity Infinity Infinity
Af subchassis	J619-10	Infinity
Xtal osc subchassis	J410-E J410-F J410-B	11 ohms 11 ohms Infinity
Vfo subchassis	J709-D to J709-J J709- D J709-E to J709-K J709-E J709-1H	13 ohms Infinity 13 ohms Infinity Infinity

43. Equipment Performance Check

Operate the equipment as described in the equipment performance checklist (TM 11-5820-358-20). If the results of these checks indicate trouble in a particular subchassis, go directly to the indicated subparagraph in the troubleshooting chart (para 46).

44. High-frequency Oscillator Injection Voltage Tests (fig. 43)

Check the conversion oscillators (V207, V401, and V701) to see if they are oscillating; proceed as follows:

a. Turn the FUNCTION switch to STAND BY to remove B+ from all tubes except the conversion oscillators. The cathodes and control grids of the mixers act as rectifiers of the oscillator voltage at testpoints E209, E210, and E211. The voltage at test point E402 (fig. 46) is the grid leak bias at the control grid of V401.

b. Check the dc voltage at test points E209, E210, E211, and E204 with the

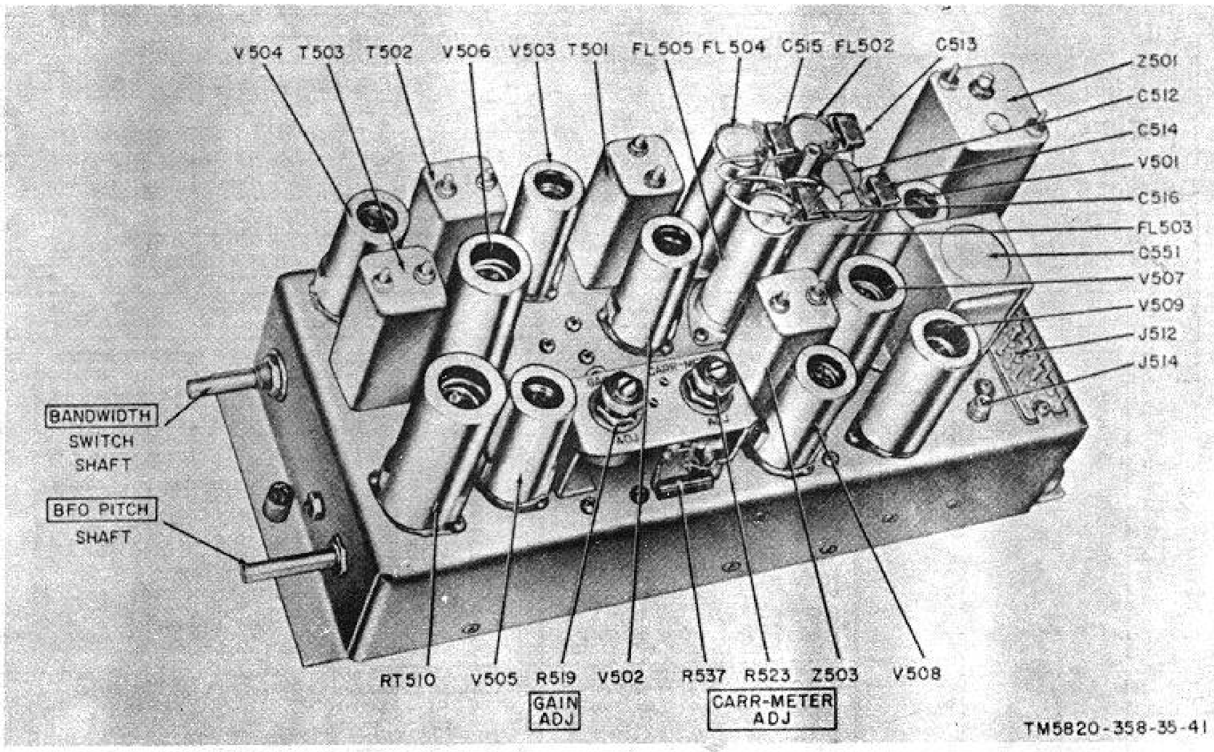


Figure 38. Unmodified if. subchassis, top view.

TS-505(*)/U. The voltages should be as follows:

Test point	Voltage
[a]E209	-6.8 (approx)
E210	-3.5 to -8
E211	-2.8 to -4.3
E402 (fig. 46)	-4 to -11

[a]To obtain a meter indication at test point E209, the receiver must be tuned below 8 mc.

45. Overall Receiver Gain Test

The overall receiver gain test checks receiver operation from the antenna through detector V506B. If the result of this test is normal, the fault is in the audio portion of the receiver.

a. Connect the receiver and the test equipment as shown in figure 57.

b. Set the TS-505(*)/U FUNCTION switch to -DC and the RANGE switch to 10V.

c. Set the output of the AN/URM-25(*) to 10 microvolts.

d. Tune the AN/URM-25(*) and the receiver to the same frequency. Readjust the KILOCYCLE CHANGE control slightly for a maximum TS-505(*)/U indication.

e. Adjust the output of the AN/URM25(*) for a TS-505(*)/U indication of -7 volts.

f. If the AN/URM-25(*) output is between 1 and 4 microvolts, the overall gain of the receiver is normal.

g. If the AN/URM-25(*) output is above or below the limits set in f above, readjust the AN/URM-25(*) output for 2 microvolts. Adjust GAIN ADJ control R519 (fig. 38) for a TS-505(*)/U indication of -7 volts. If this adjustment fails to restore normal operation, the fault is in the rf, the if., or the detector portion of the receiver.

46. Troubleshooting Chart

a. General. The troubleshooting chart outlines the procedures for localizing trouble to a stage in the rf, if., af, vfo, or power-supply subchassis.

b. Use of Chart. This chart supplements the troubleshooting checks in TM 115820-358-20. If previous checks have resulted in reference to a particular subchassis, go directly to the referenced subchassis.

***Caution:* If no symptoms are known, make the short-circuit tests (para 41 and 42) before starting with step 1 of the troubleshooting checks in TM 11-5820-358-20.**

c. Conditions for Tests. Connect the receiver to the ac power source, and set its controls (para 36).

d. Troubleshooting Chart (fig. 53 and 54).

***Note:* Perform the equipment performance checks in TM 11-5820-358-20 before using this chart unless the trouble has already been localized.**

(1) *Power-supply subchassis.*

Item	Indication	Probable trouble	Procedure
1	Receiver fails to operate; tubes and dial lamps do not light. (Fuses do not blow).	*a.* Defective ac power contacts in FUNCTION switch or open filter FL101 (fig. 56).	*a.* Disconnect receiver from power source. Disconnect P111 (fig. 37). Check continuity between AC 3 AMP fuse F101 and P111-7. Check FLI01 for continuity.
		b. Power transformer T801 primary windings open.	*b.* Check continuity between J811-4 and J811-7 for 115-volt operation; or between J8114 and J811-7, and J811-6 and J811-7 for 230-volt operation.
		c. Loose connections or improper wiring to TB801.	*c.* Remove power-supply subchassis (TM 11-5820-358-20) and check TB801.
		d. Open 6.3-voltwinding. J811-11.	*d.* Check continuity between J811-10 and
		e. Open 25.2-volt winding.	*e.* Remove V801 and V802. Check continuity between J811-1 and J811-11.
2	Receiver fails to operate; tubes and lamps light.	Open 570-volt winding.	Disconnect receiver from power source. Remove V801 and V802. Check for 74 ohms between pin 1 of V801 and pin I of V802.

(2) *Af subchassis.*

Item	Indication	Probable trouble	Procedure
1	No line or local af output.	*a.* No B+ to af circuits.	*a.* Disconnect receiver from power source. Disconnect P111 and P119 (fig. 37). (Check for continuity between P111-5 and P119-5. Remove af subchassis (TM 11-5820-358-20). Check for open L601 or L603 by continuity test between NO603 pin 7, and J619-5 (fig. 51 and 52).
		b. Defective first af amplifier or af cathode follower stage.	*b.* Check circuit components of V601 (fig. 51), including P120 and audio response switch S104 (fig. 56).
		c. Defective break-in relay K601.	c. Check K601 contacts (fig. 51).
2	Line af output, but no local af output.	Defective local af amplifier or af output stage.	Find defective stare by signal substitution (par; 47). Check circuit. components of defective stage.
3	Local af output, but no line af output.	Defective line af amplifier or af output stage.	Same as item 2.

(3) If. subchassis.

Item	Indication	Probable trouble	Procedure
1	No audio output when receiver is tuned to any station.	a. Defective if. amplifier stage. b. No B+ to if. circuits.	a. Use signal substitution (para 47) to find defective stage. Check circuit components of defective stage. b. Disconnect P119 (fig. 37) from J619. Check for open filter choke L601 or L602 by testing for B+ at J619-2. Reconnect P119 and disconnect P112 (fig. 36). Check for B+ at P112-2. If B+ is present at J619-2 and not at P112-2, the trouble is in FUNCTION switch or main frame wiring (fig. 87).
2	Some stations received much louder than others.	Defective age circuit.	Tune receiver to strong station. Check for age voltage at TB102-3 on receiver rear panel. Check at E208, E209, E210 (fig. 43), and the control grids of V501, V502, and V503 (fig. 39) for ago voltage. If no age voltage is present at TB102-3, use voltage and resistance diagram to check circuit components of V506, V508, and V509A.
3	Noise does not drop sharply between detent positions of MEGACYCLE CHIANGE control.	If. gain set too high.	Adjust if. gain control (para 73).
4	Set operates normally but CARRIER LEVEL meter does not indicate.	Defective meter M102 (fig. 56) or meter circuit.	Check meter by substitution. Use voltage and resistance diagram to check cathode circuit components of V504 and V506A (fig. 38 and 42).
5	Set operates normally but noise limiter does not operate.	Defective noise limiter switch or limiter stage.	Check LIMITER control (S108 and R120) (fig. 56). Use voltage and resistance diagram (fig. 60) to check circuit components of V507.
6	Set operates normally but BFO does not operate.	No B+ to V505.	Turn BFO switch S101 to ON. Use voltage and resistance diagram (fig. 60) to isolate defective component of bfo stage or switch S101.

(4) VFO subchassis.

Item	Indication	Probable trouble	Procedure
1	A Few strong stations are received, but inaccurate frequency identification.	Defective vfo stage.	Use voltage and resistance diagram (fig. 61) to isolate defective component in vfo.
2	Excessive error at one end of the KILOCYCLE CHANGE control after extreme other end has been calibrated.	Aging has caused vfo range to change.	Reset vfo end point (para 81).

(5) *Rf subchassis.*

Item	Indication	Probable trouble	Procedure
1	Receiver inoperative, but tubes and dial lamps light.	*a.* No B+ to rf circuits.	*a.* Same as procedure for second paragraph of (3) above.
		b. Defective rf or mixer stage.	*b.* Use oscillator injection voltage tests (para 44) to check oscillators. Use signal substitution (para 47) to locate defective stage. Use voltage and resistance diagram (fig. 58) to isolate defective component.
		c. Receiver out of synchronization.	*c.* Resynchronize receiver (para 70).
		d. Defective antenna relay assembly K101.	*d.* Check K101 (fig. 36 and 55) for ground, open, or pitted contacts.
2	Receiver operates above 8 mc only.	Defective V202 or V207 stage.	Use voltage and resistance diagram (fig. 58) to isolate defective component.
3	Rf noise is maximum when MEGACYCLE CHANGE control is out of detent position.	Mistracking rf coils.	Realign rf coils (para 77).
4	Receiver operates, but calibration signal not audible on any band.	No B+ to calibration oscillator circuits.	Disconnect P108 (fig. 36) from J208. Check for B+ at P108-J; if not present, trouble is in FUNCTION switch or main-frame wiring. Use voltage and resistance diagram (fig. 58) to isolate defective component in V205 or V206 circuits.
5	Inaccurate frequency identification when receiver is calibrated.	Calibration oscillator off frequency.	Adjust calibration oscillator (para 79).
6	Same as item 3 of (3) above.		

(6) *Crystal oscillator subchassis.*

Item	Indication	Probable trouble	Procedure
1	Receiver inoperative, but tubes and dial lamps light.	*a.* No +150-volt regulated dc to crystal-oscil-Lator circuits.	*a.* Turn FUNCTION switch to STAND BY. Check for +150 volts between E607 (fig. 51) and chassis ground. E607 is accessible through hole inside of main frame. If voltage is not present, check voltage regulator circuit on the af subchassis.
		b. No B+ to plate circuit of V401.	*b.* Turn FUNCTION switch to AGC. Disconnect P110 (fig. 36) from J410. Check for +150 volts at P110-C. Check for B+ P110-A. Use voltage and resistance diagram (fig. 59) to isolate defective component.
2	Noise on any hand is less than on an adjacent band.	Crystal-oscillator trimmers misadjusted.	Realign crystal-oscillator trimmers (para 74).
3	Calibration signal audible on only one band.	Crystal-oscillator shaft disengaged.	Check (para 70*e*) and tighten shaft coupler (fig. 36).

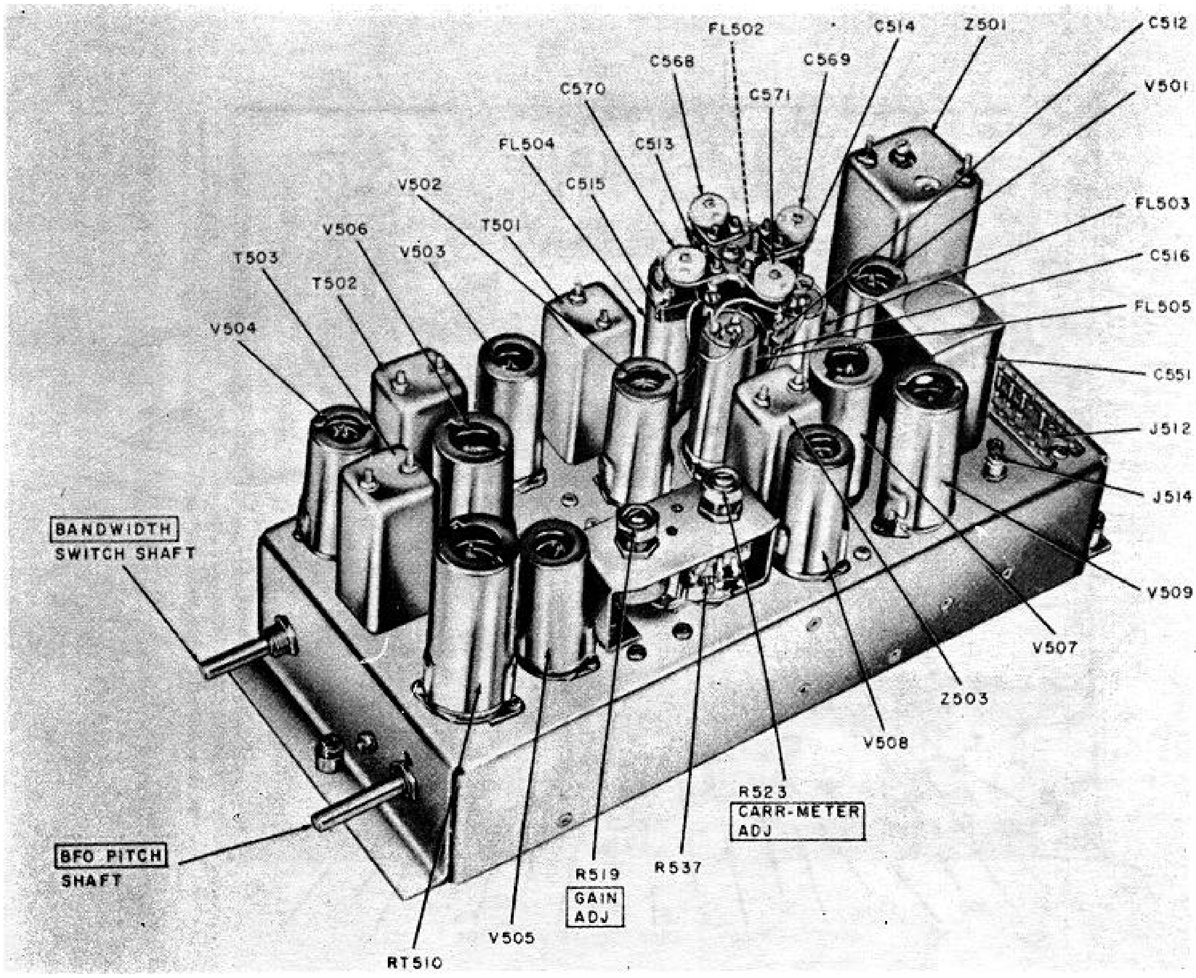


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Figure 39. If. subchassis, MOD 1, Order No. 363-Phila-54 and all if. subchassis on Order No. 14-Phila-56, top view.

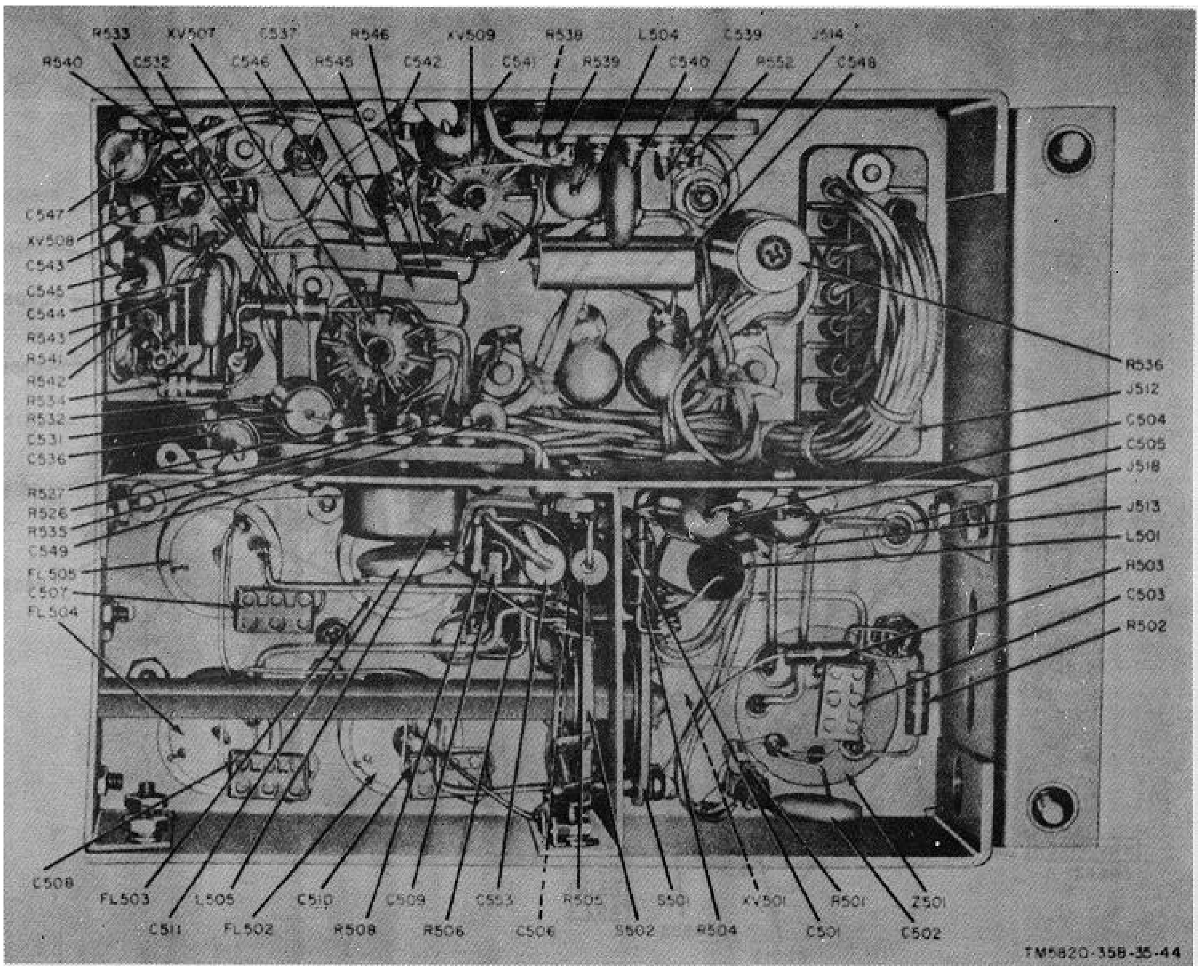


Figure 40. Unmodified if. subchassis, bottom view, rear section.

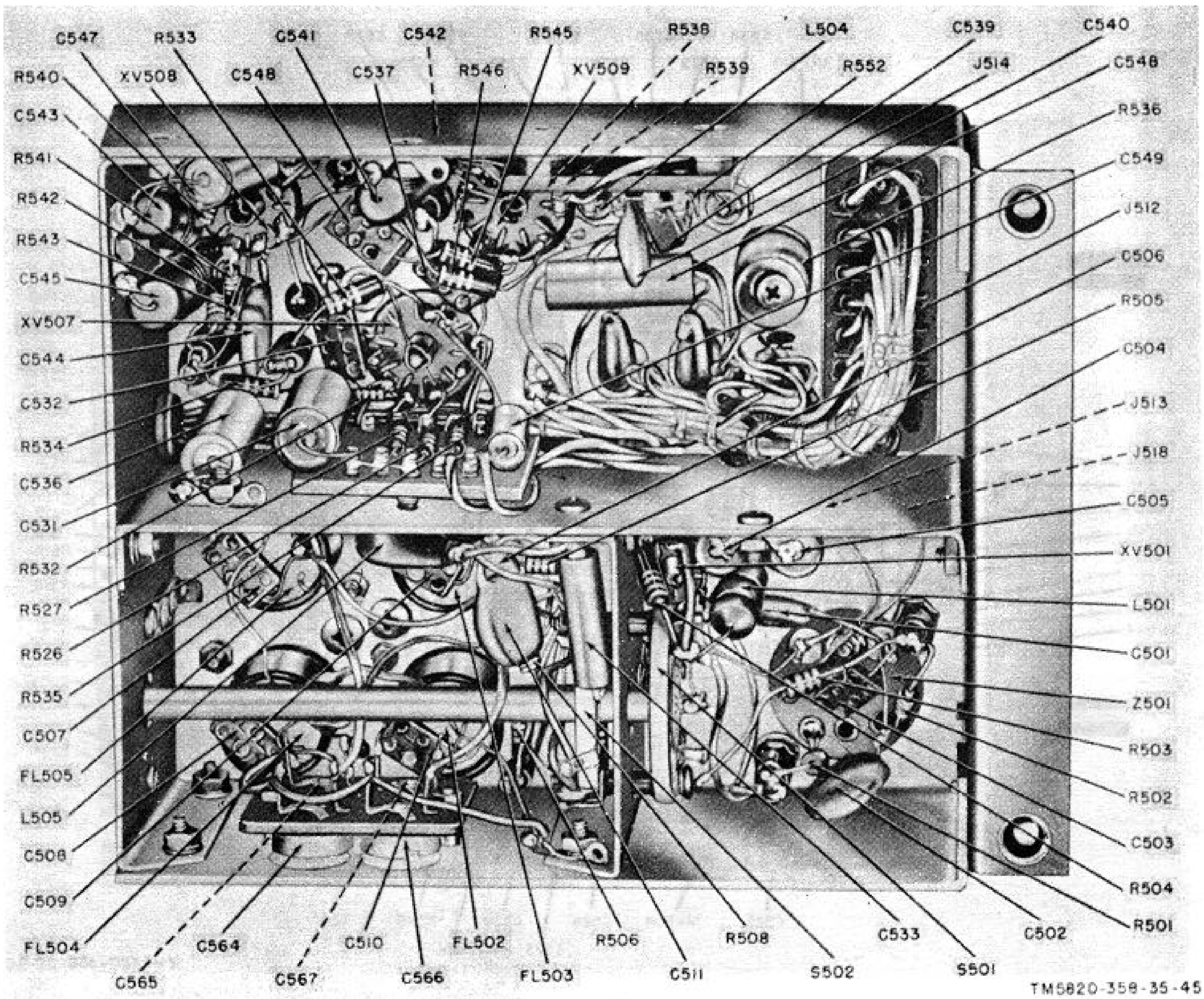


Figure 41. If. subchassis, MOD 1, Order No. 363-Phila-54 and all if. subchassis on Order No. 14-Phila-56, bottom view, rear section.

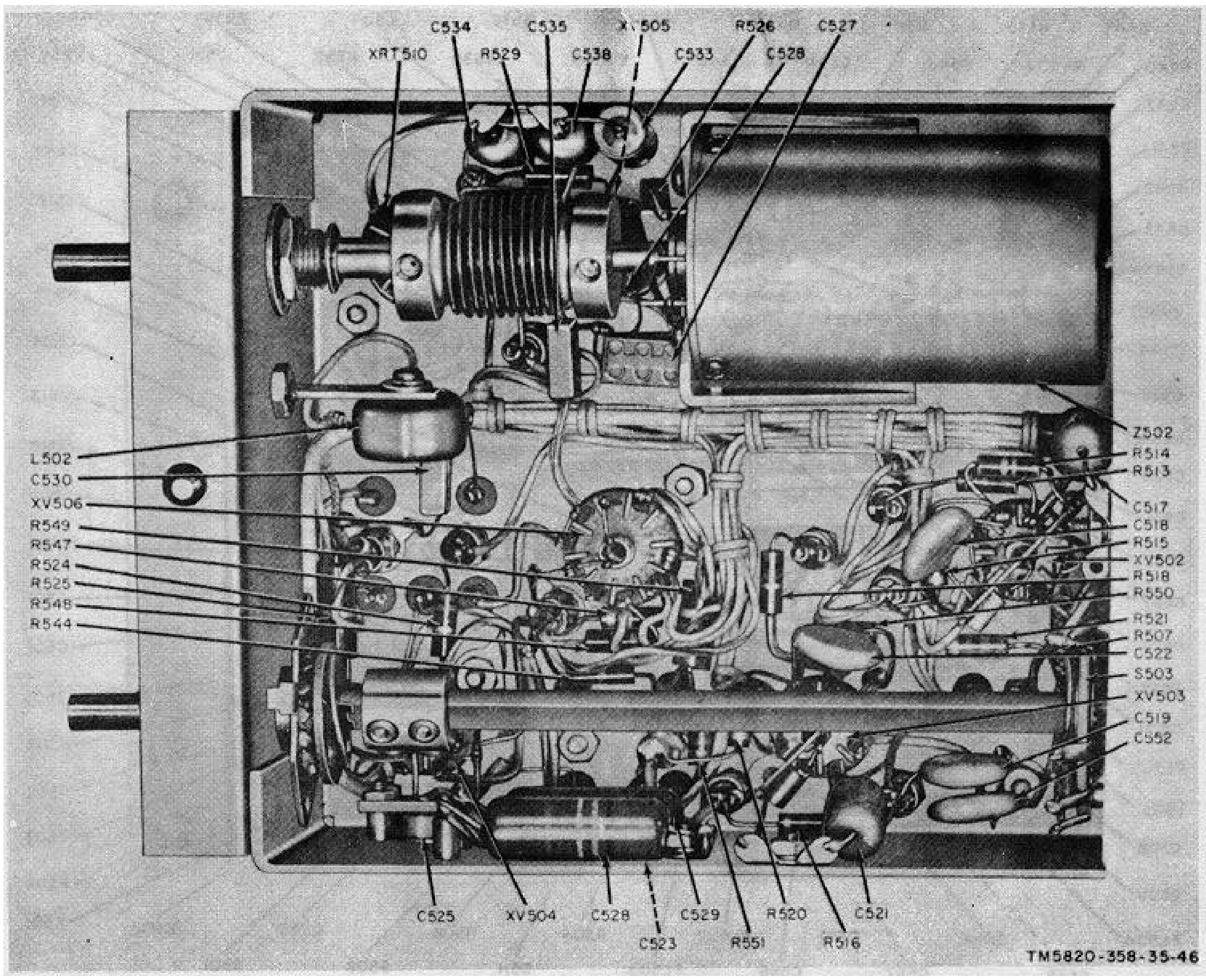


Figure 42. If. subchassis, bottom view, front section.

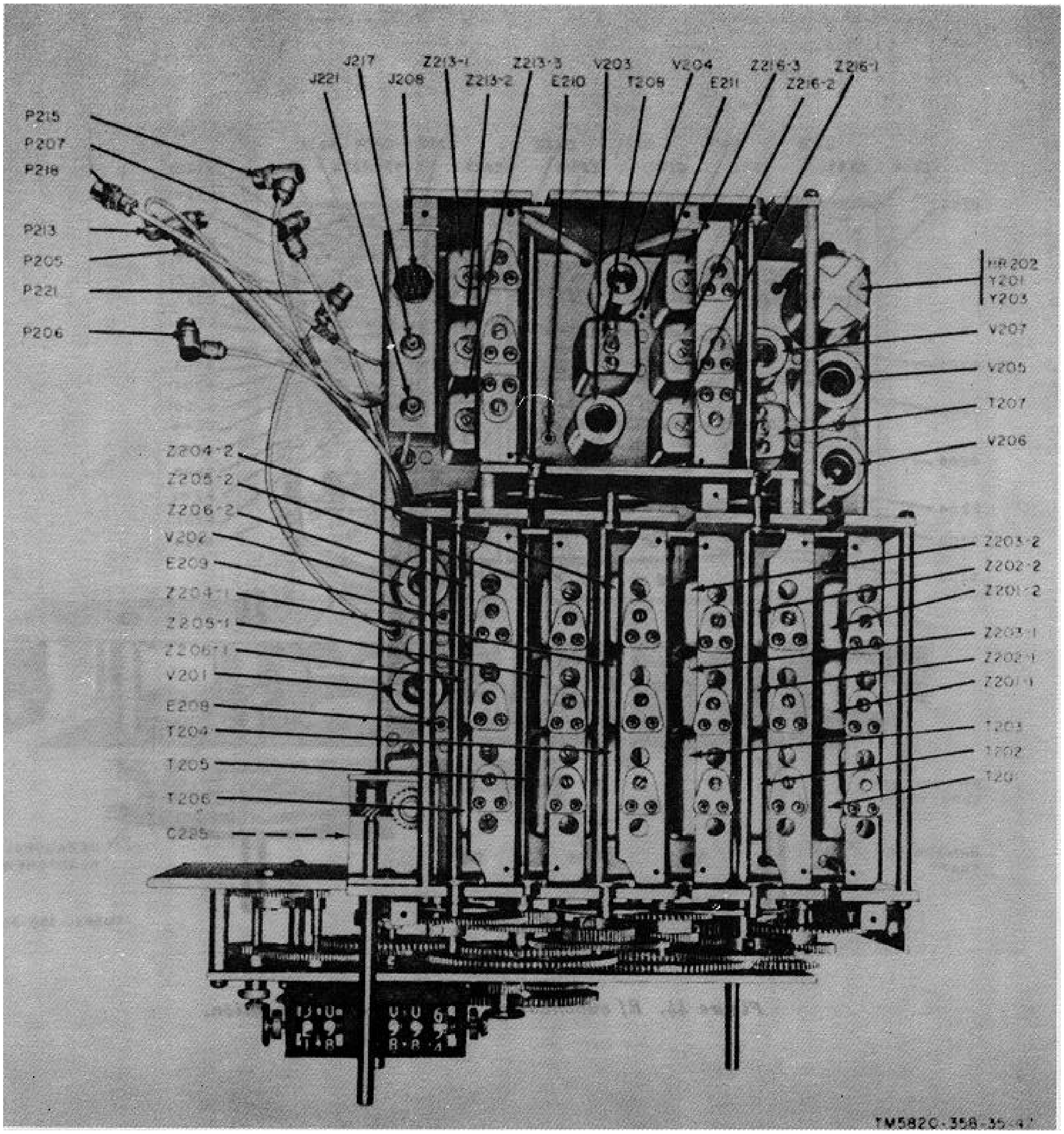


Figure 43. Rf subchassis, top view.

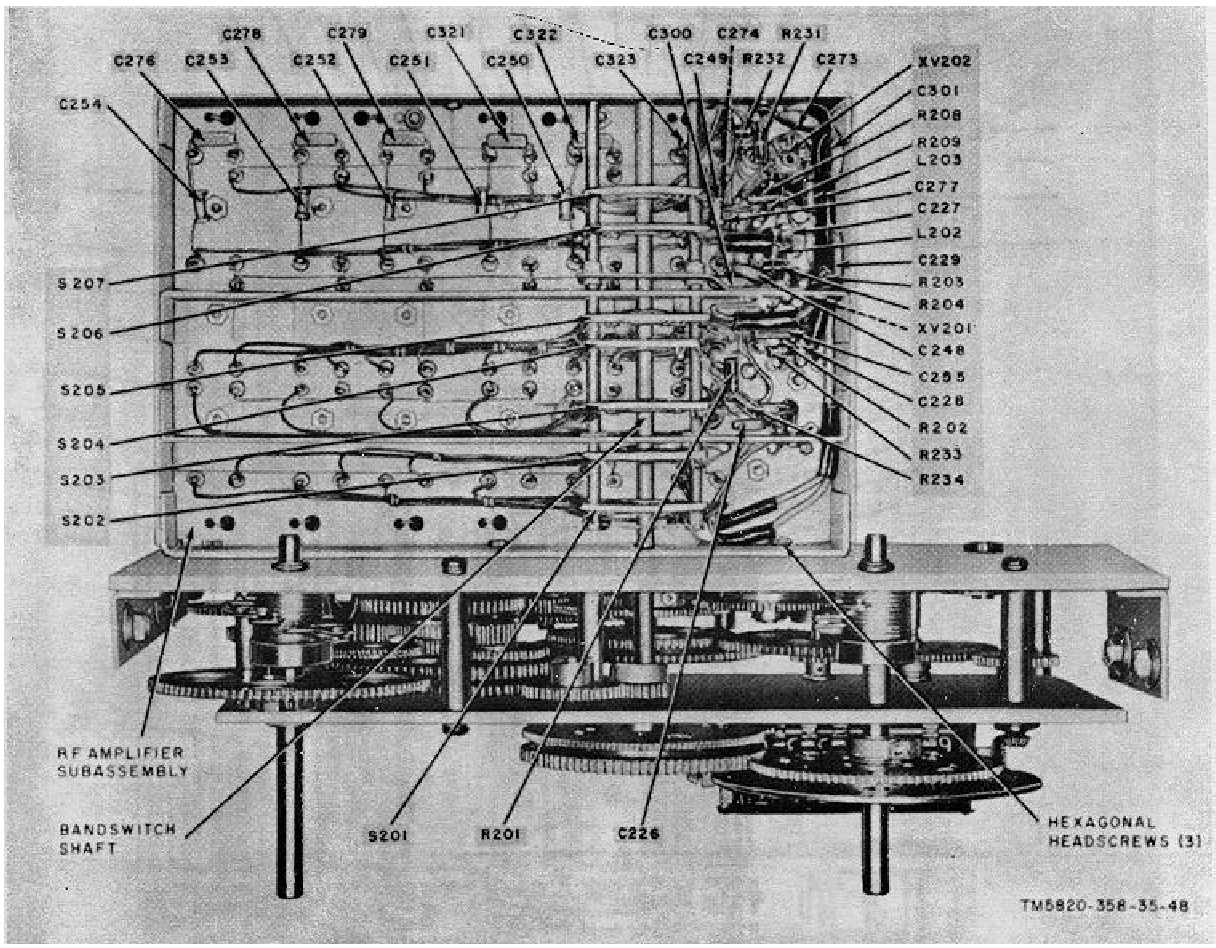


Figure 44. Rf subchassis, bottom view, front section.

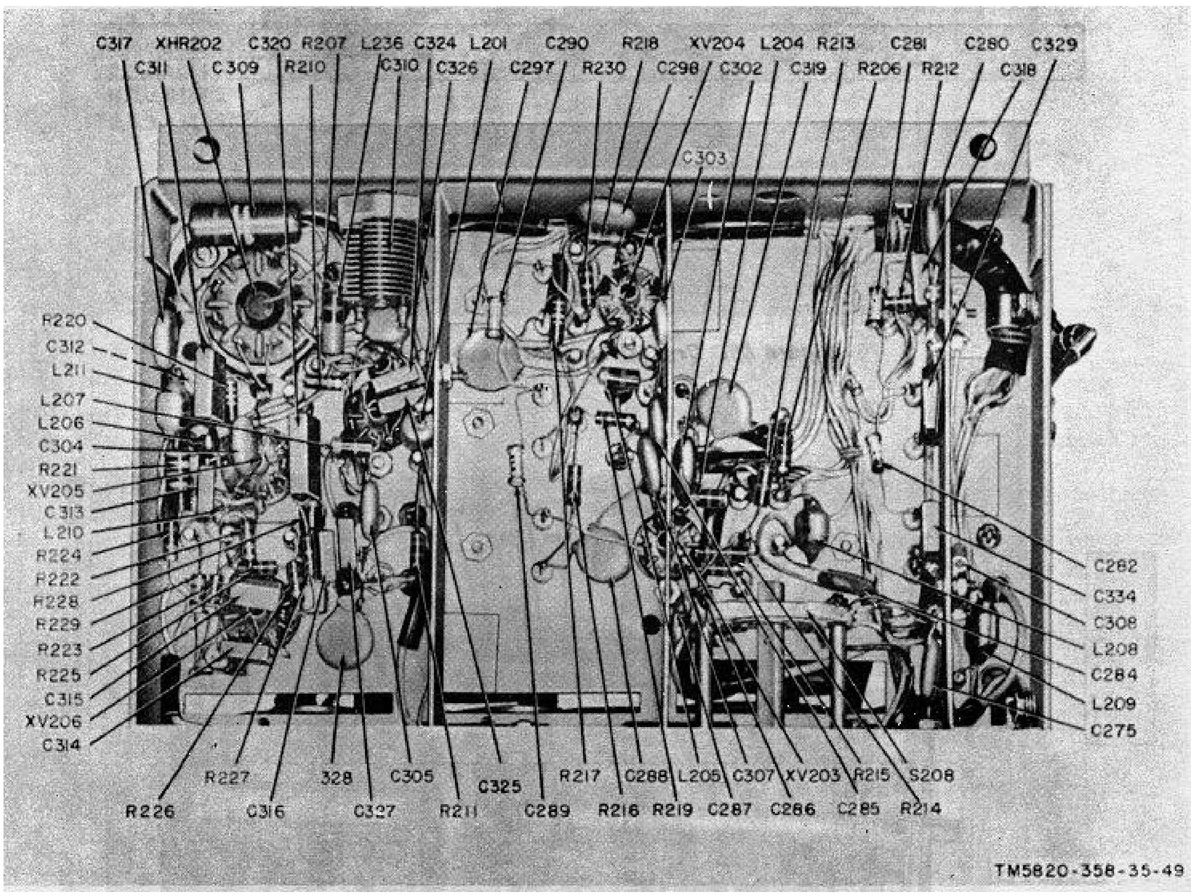


Figure 45. Rf subchassis, bottom view, rear section.

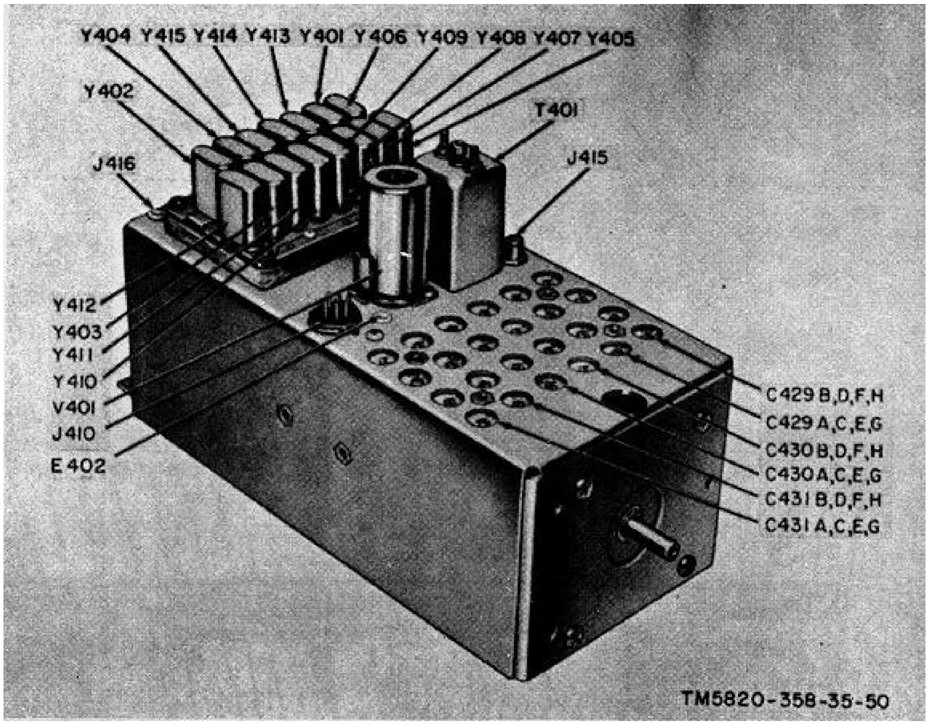


Figure 46. Crystal-oscillator subchassis, top view.

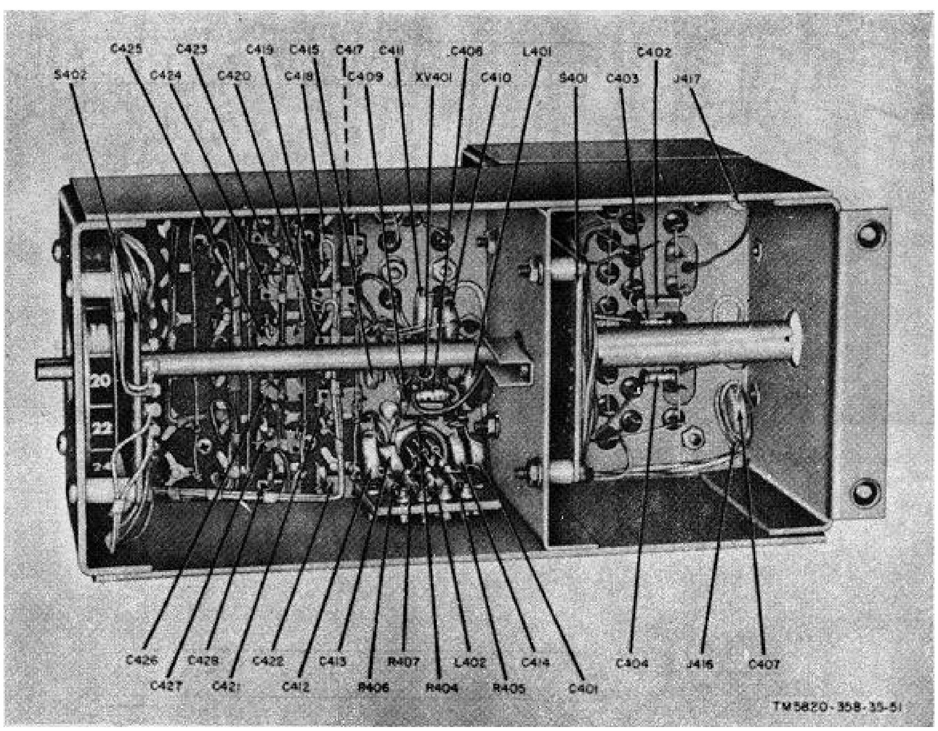


Figure 47. Crystal-oscillator subchassis, bottom view.

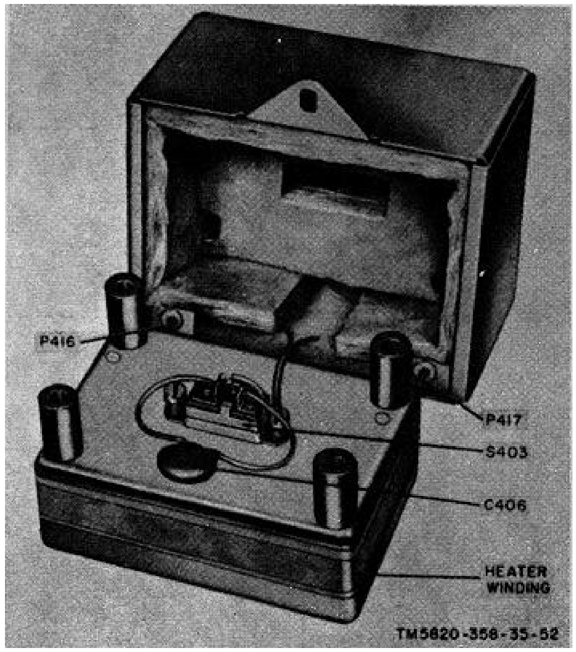


Figure 48. Crystal-oscillator subchassis, internal view of crystal oven.

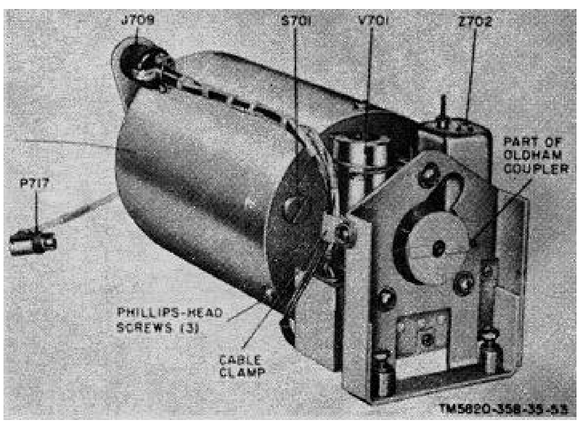


Figure 49. Vfo subchassis, top view.

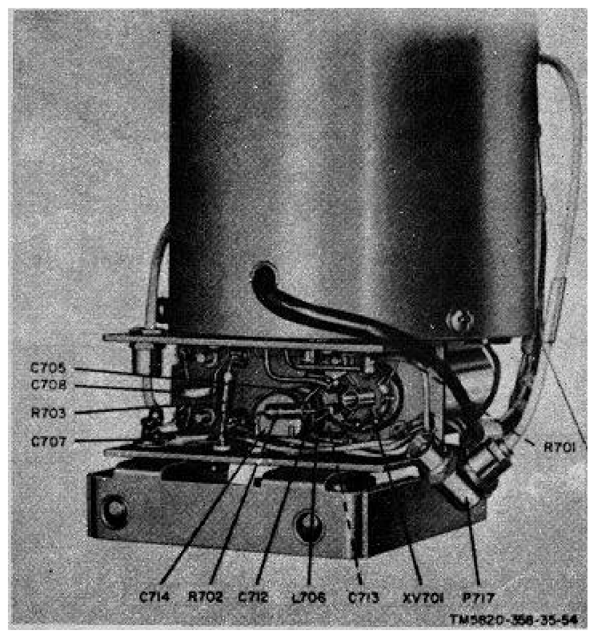


Figure 50. Vfo subchassis, bottom view.

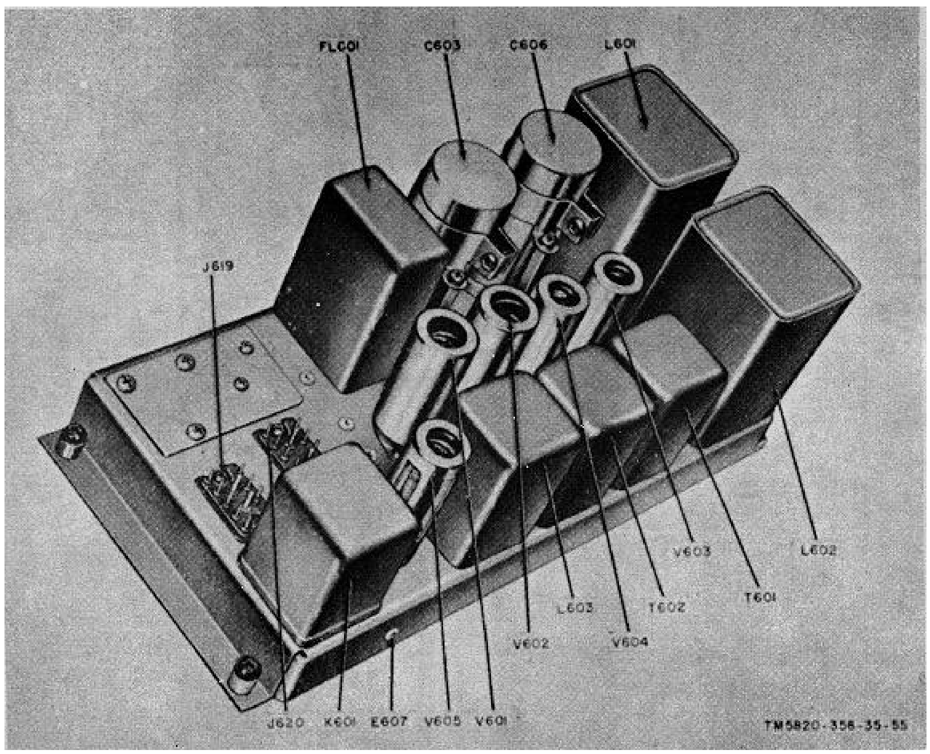


Figure 51. Af subchassis, top view.

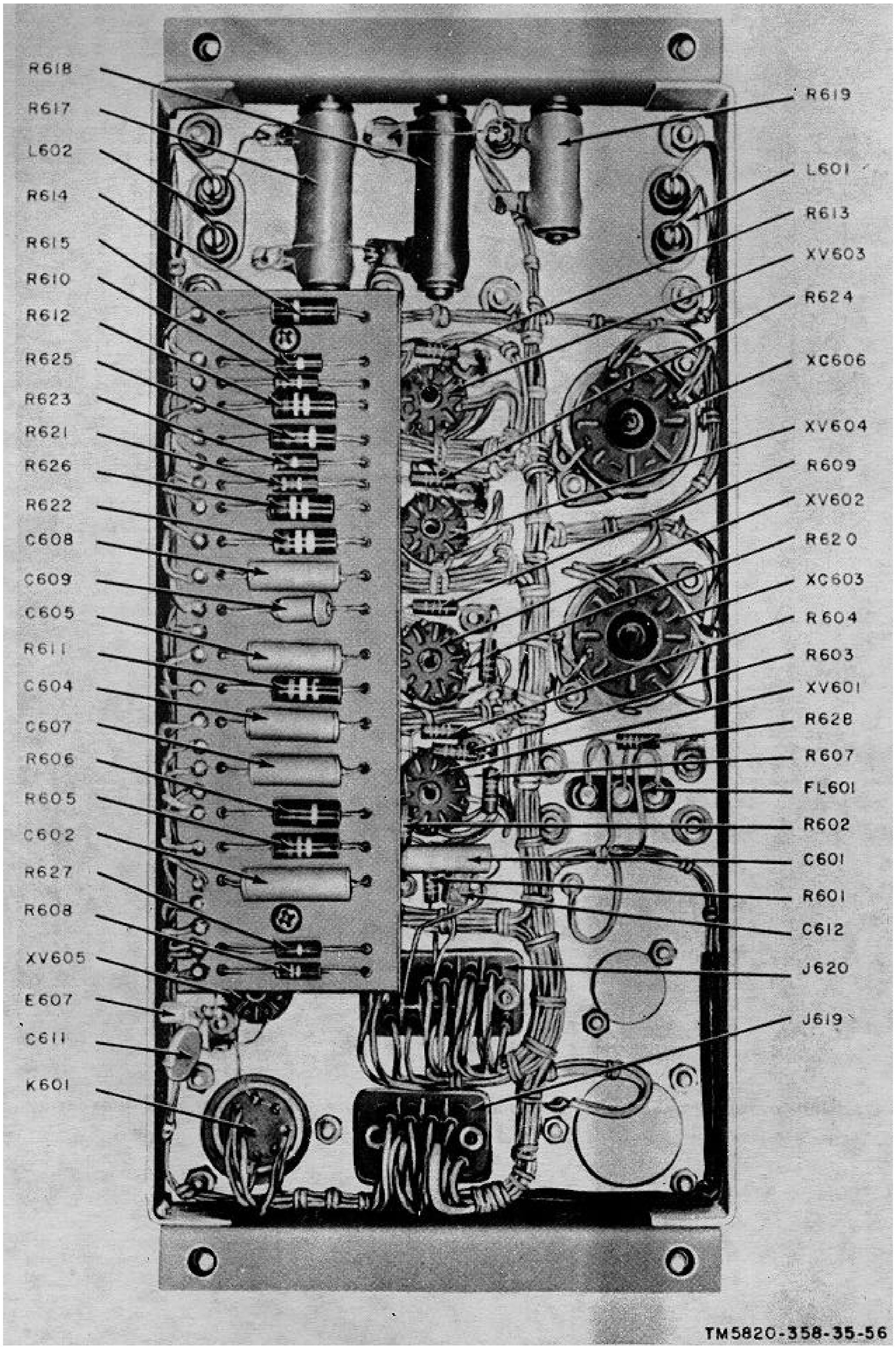


Figure 52. Af subchassis, bottom view.

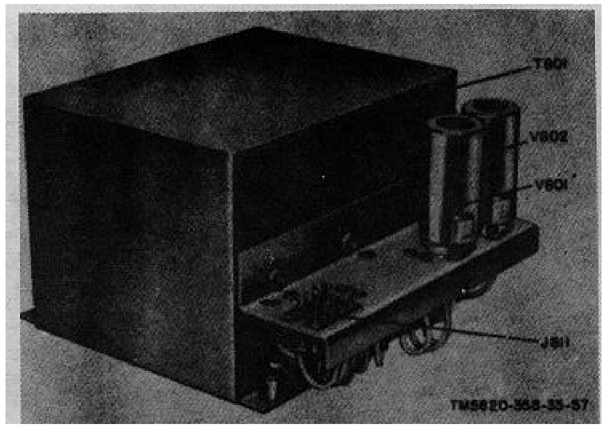


Figure 53. Power-supply subchassis, top view.

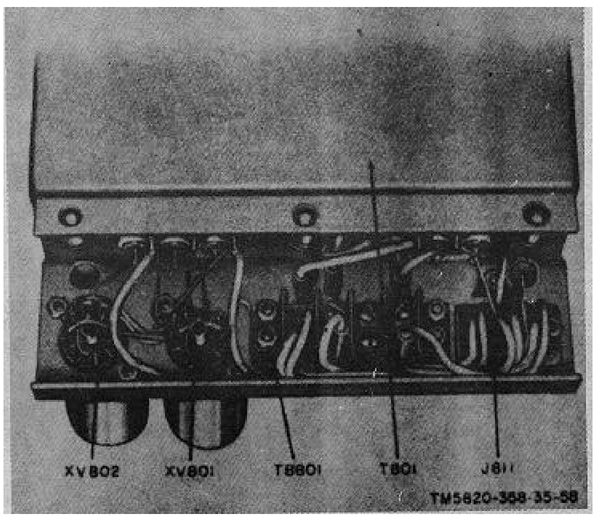


Figure 54. Power-supply subchassis, bottom view.

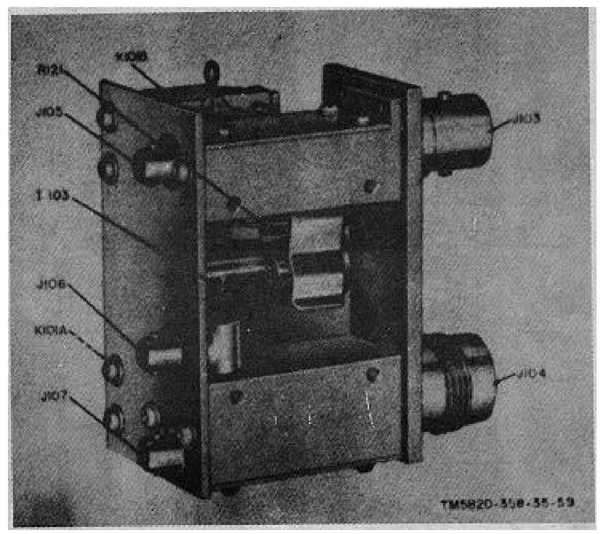


Figure 55. Antenna relay assembly, internal view.

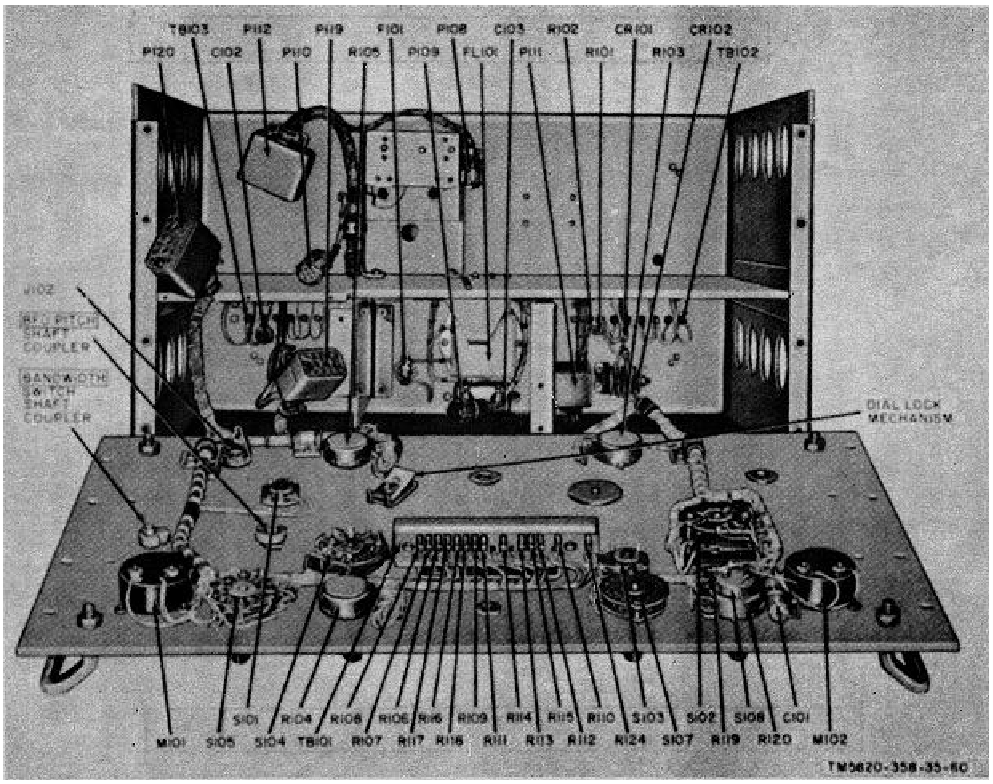


Figure 56. Radio Receiver R-390A/URR, front panel and interior of main frame.

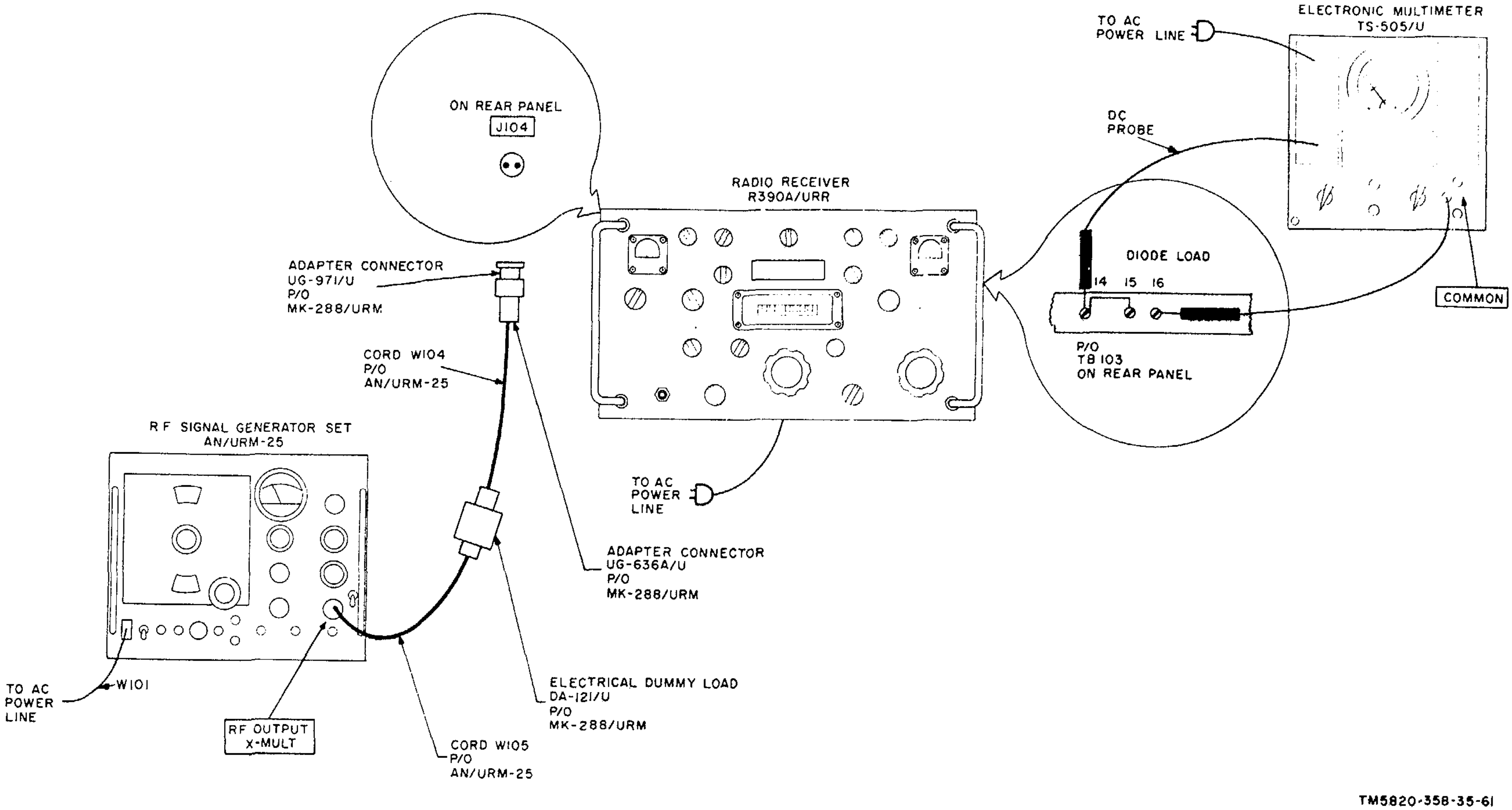


Figure 57. Overall receiver gain test setup.

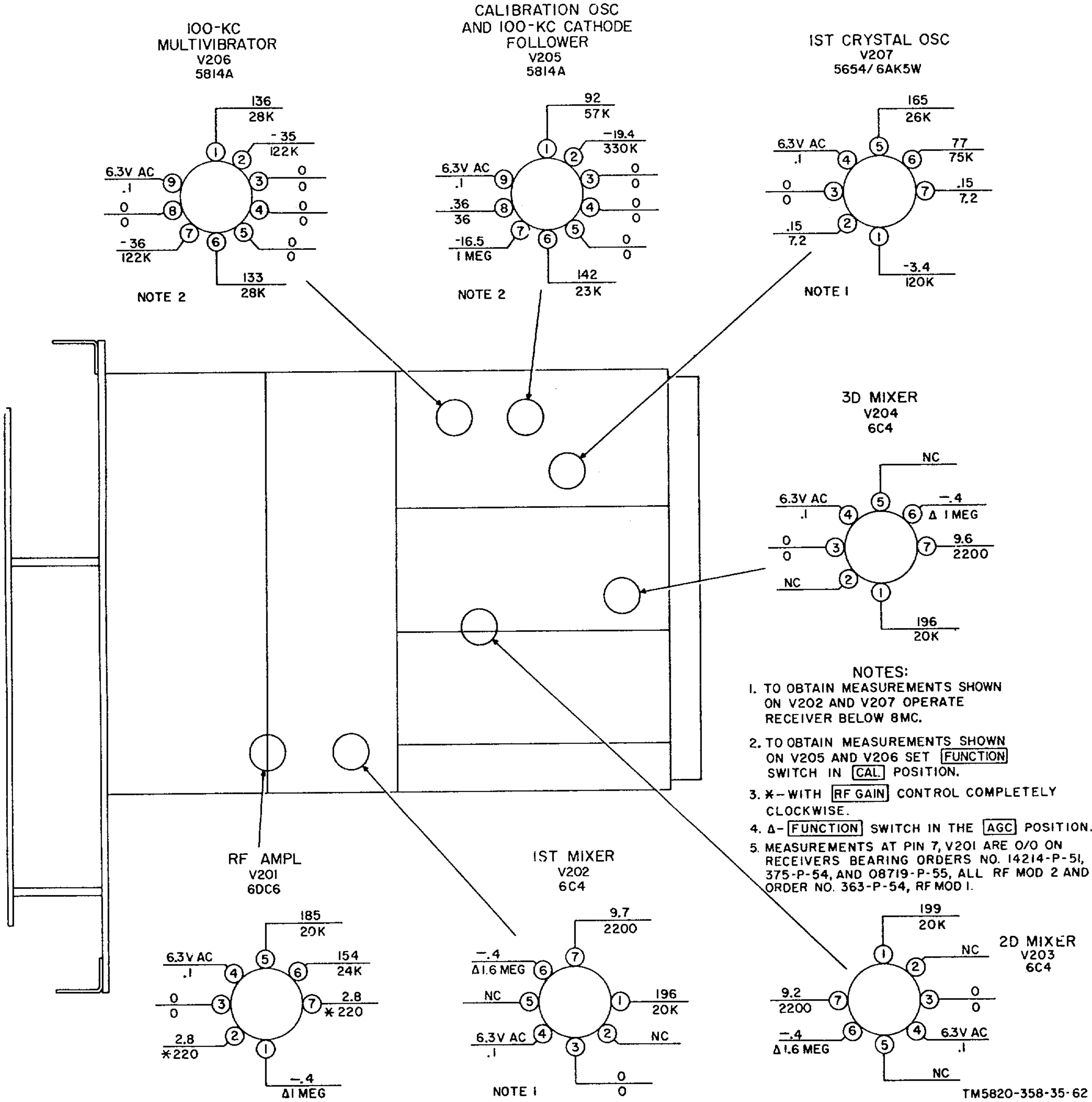


Figure 58. Rf subchassis, voltage and resistance diagram.

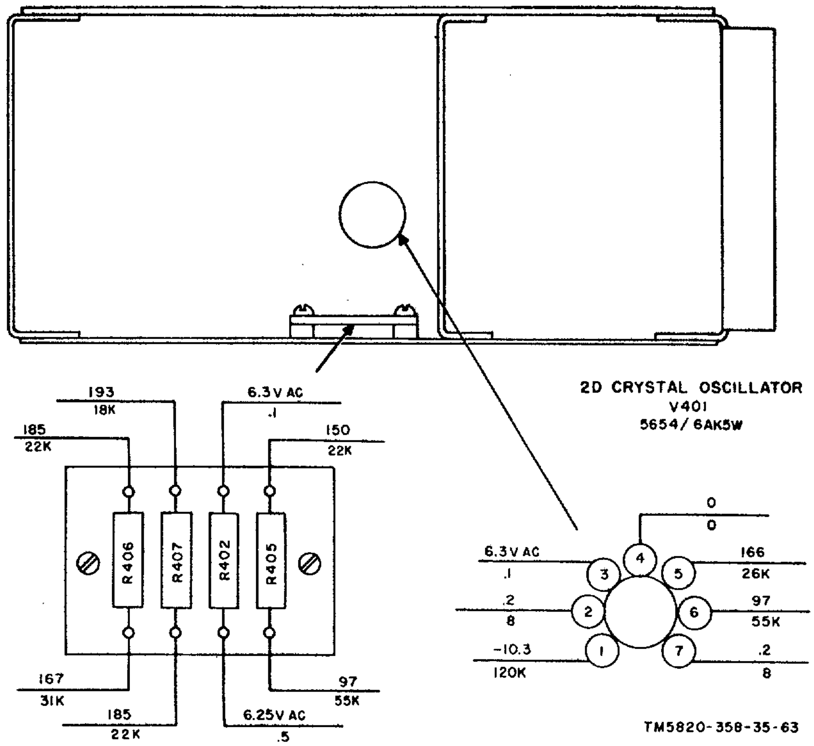
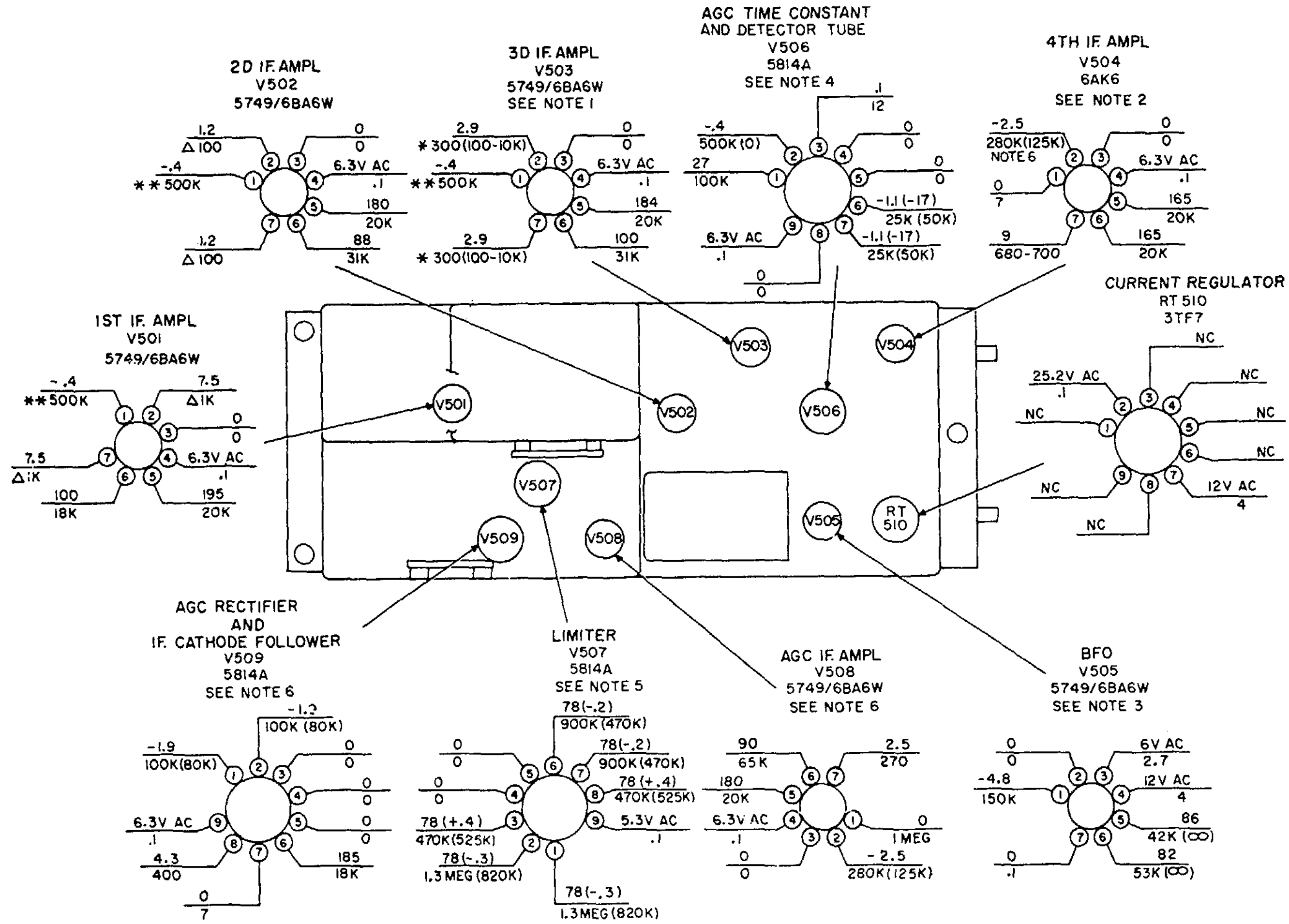


Figure 59. Crystal-oscillator subchassis, voltage and resistance diagram.



NOTES:

1. VOLTAGE AND RESISTANCE READINGS ON V503 ARE WITH A NORMAL SETTING OF THE GAIN ADJ CONTROL R519. MINIMUM (CLOCKWISE) AND MAXIMUM (COUNTER-CLOCKWISE) SETTINGS CHANGE VOLTAGE READINGS AS FOLLOWS:

	PIN NO.			
R519	2	5	6	7
MIN	19	196	144	19
MAX	1.3	178	85	1.3

* RESISTANCE VALUES IN ( ) INDICATE RANGE OF READINGS DEPENDING UPON SETTING OF R519.

2. RESISTANCE OF PIN 7 VARIES WITH SETTING OF CARR-METER ADJ CONTROL R523.

3. SET BFO SWITCH TO ON POSITION. RESISTANCE VALUES OF PINS 5 AND 6 IN ( ) ARE TAKEN WITH BFO SWITCH IN OFF POSITION.

4. RESISTANCE READING OF PIN 2 IN ( ) TAKEN WITH FUNCTION SWITCH SET TO MGC. VALUES OF PINS 6 AND 7 IN ( ) TAKEN WITH LIMITER CONTROL SET TO 10.

5. VALUES IN ( ) TAKEN WITH LIMITER CONTROL SET TO 10.

6. RESISTANCE VALUES IN ( ) TAKEN WITH FUNCTION SWITCH SET TO MGC.

7. Δ RF GAIN CONTROL COMPLETELY CLOCKWISE

8. ** FUNCTION SWITCH IN AGC POSITION.

Figure 60. If. subchassis, voltage and resistance diagram.

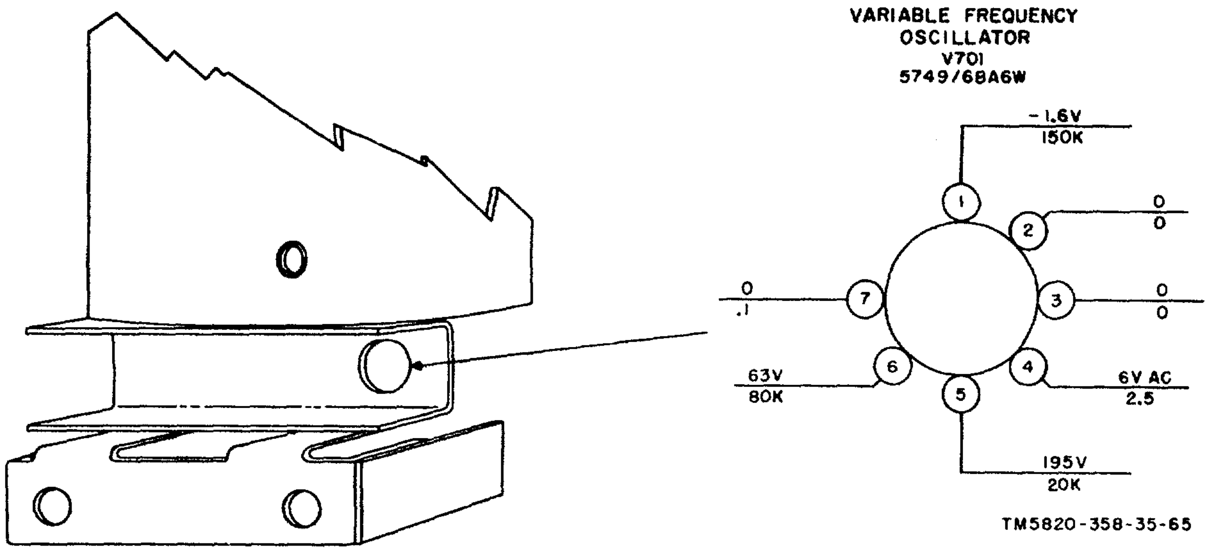


Figure 61. Vfo subchassis, voltage and resistance diagram.

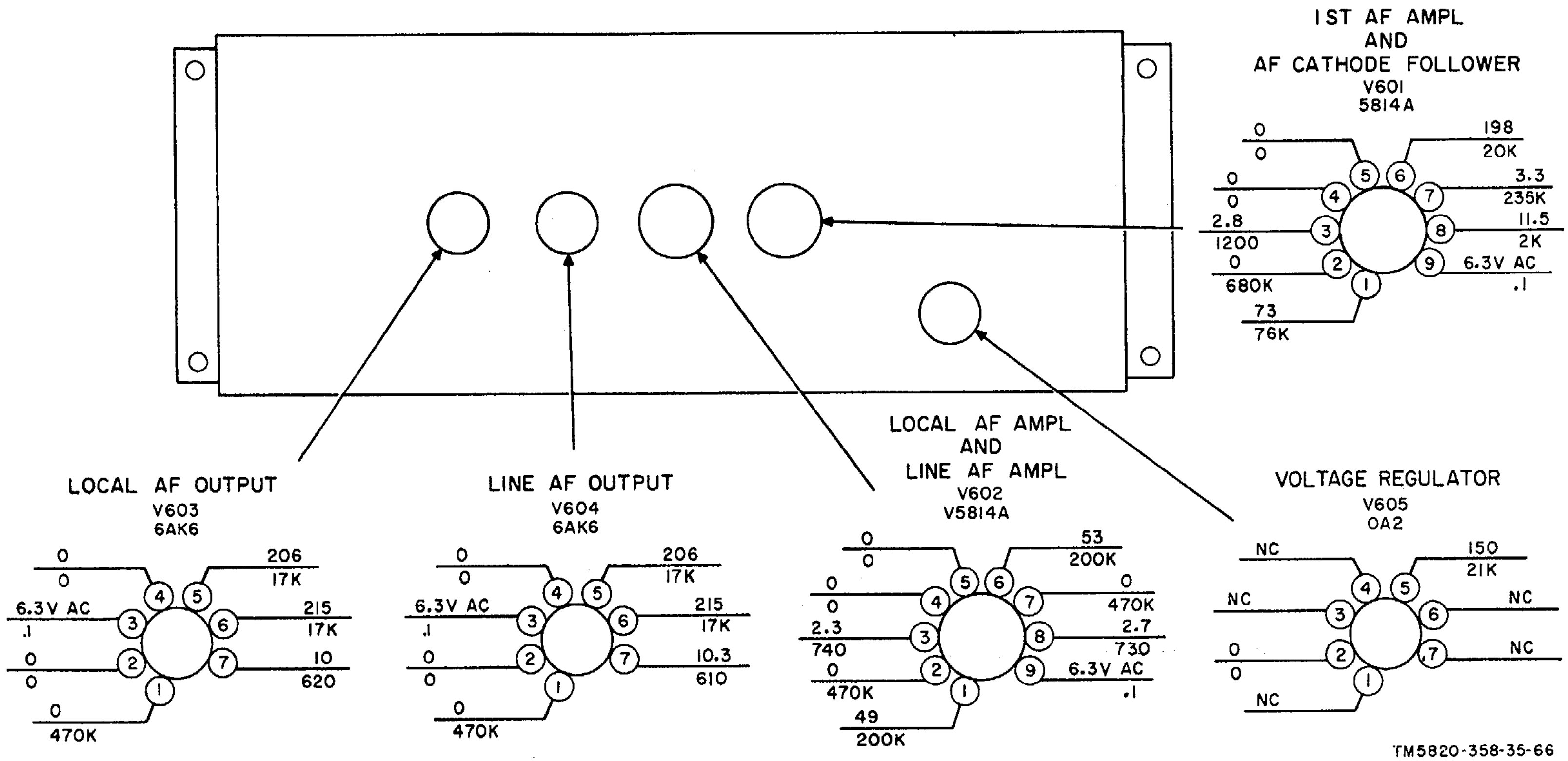


Figure 62. Af subchassis, voltage and resistance diagram.

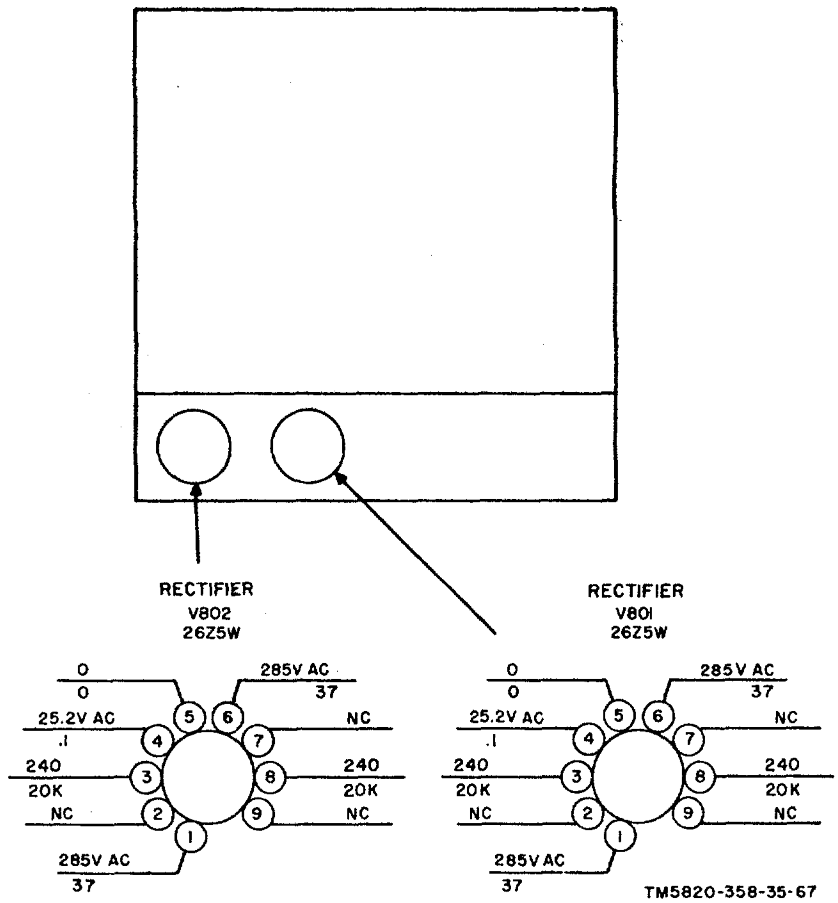


Figure 63. Power-supply subchassis, voltage and resistance diagram.

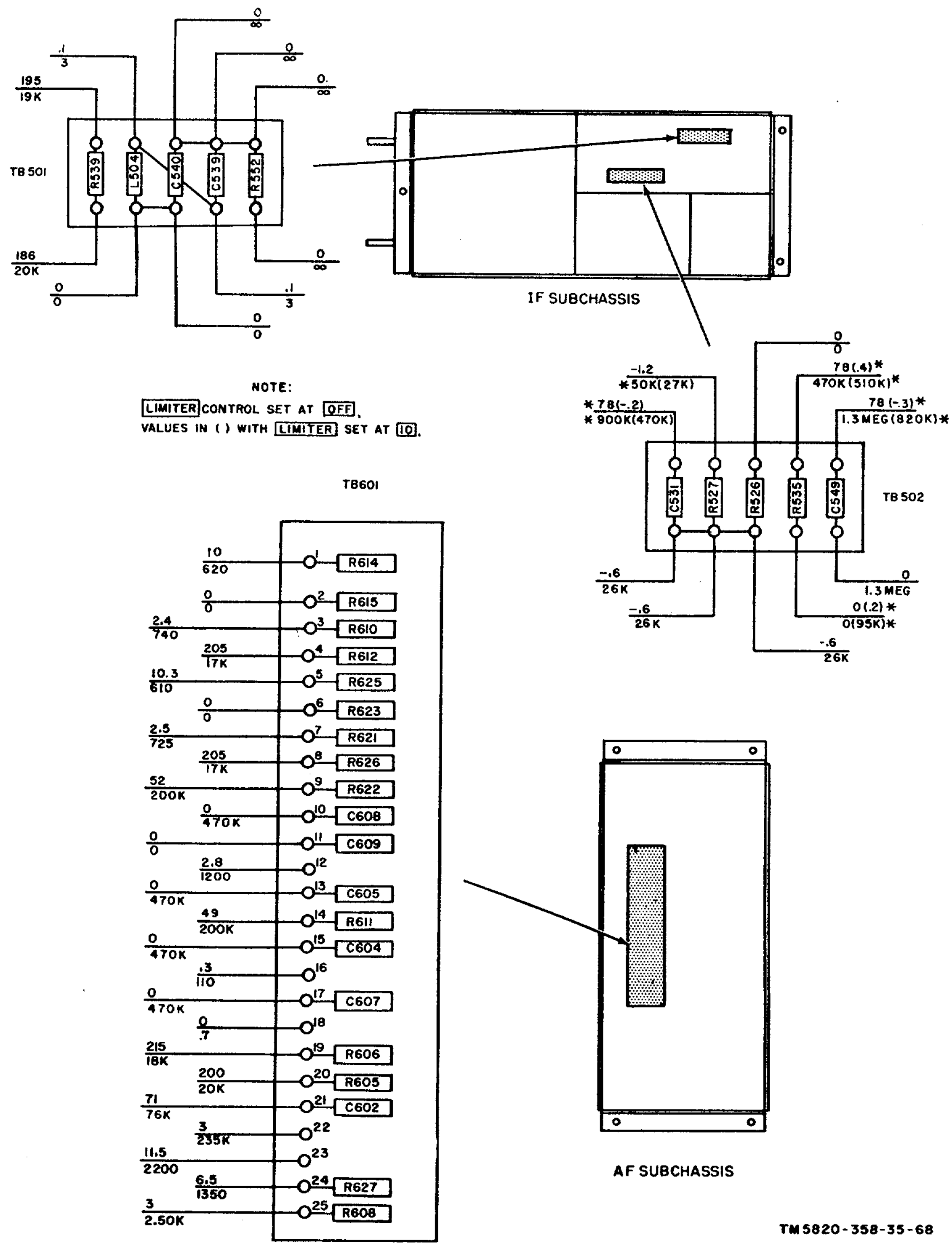


Figure 64. If. and af subchassis resistor and capacitor terminal boards, voltage and resistance diagram.

47. Signal Substitution Chart

Signal substitution supplements the general troubleshooting procedures. Use signal substitution when voltage and resistance measurements fail to isolate the trouble, and in the if. and af subchassis, to rapidly localize trouble to a particular stage. An externally generated signal from the TS-382(*)/U or the AN/URM-25(*) is substituted for the signal present in each stage. The test equipment required is listed in paragraph 34.

a. Preset the receiver front-panel controls (para 36).

b. When using the TS-382(*)/U, connect its ground lead to the receiver chassis and its hot lead through a 0.5 uf, 400-volt capacitor to the desired test point. Set the TS-382(*)/U frequency at 800 cycles per second for all tests.

c. When using the AN/URM-25(*), connect the ground lead of Test Lead CX-2919/U to the receiver chassis and its hot lead to the desired test point. The CX2919/U is supplied with the AN/URM-25D or AN/URM-25F. When a modulated AN/URM-25(*) output is required, use the 1,000 cps internal modulation of the AN/ URM-25(*).

d. When performing the signal substitution tests, be sure that the AN/URM-25(*) or the TS-382(*)/U is adjusted to produce a usable receiver output; when working from the receiver output towards the antenna; reduce the signal level to zero and then raise it to a usable level. This insures that an extremely strong input signal is not overloading the receiver, or that the signal is not being brute-forced through a defective stage.

e. Observe the general precautions (para 38). Use the bench-testing (para 37) and test cable (para 35) data. Use tube test point adapters (para 39a) to avoid subchassis removal, because test jacks are not provided at all points where signals must be applied.

f. Note the volume and listen for distortion in the headset or speaker during the signal substitution procedure. If possible, compare the results with a receiver known to be operating normally.

g. A tuning shaft or band switch that is out of synchronization (para 70) or a coil slug or trimmer capacitor that is misaligned will cause reduced output or no output.

h. Each succeeding step of the signal substitution tests in the following chart assumes that the preceding steps have been made and that the previously tested stages are working normally.

(1) *Af tests* (fig. 51, 52, and 62).

Step	Test connection	Normal indication	Procedure
1	TS-382(*)/U to TB103, DIODE LOAD terminal 14. Connect headset or speaker to TB103, LINE AUDIO terminals 10 and 13, then to TB102, LOCAL AUDIO terminals 6 and 7. Note: Leave headset connected to TB102 terminals 6 and 7 for steps 2, 3, 4, and 5.	Loud clear signal heard for both connections.	If receiver passes this test, go immediately to if. subchassis tests. If receiver fails this test, proceed with step 2
2	TS-382(*)/U to pin 5 of V603.	Audio signal heard.	Check resistance of T601 windings (para 49).
3	TS-382(*)/U to pin 1 of V603.	Volume increases.	Check C605 and circuit components of V603.
4	Disconnect P120 (fig. 37) from J620. TS-382(*)/U to J620-1. *Caution*: Make sure LINE METER switch is at OFF before continuing tests.	Volume increases.	Check C604 and circuit components of V602A.
5	Reconnect P120. TS-382(*)/U to pin 8 of V601 (LOCAL GAIN control at 10).	Volume less than in step 4.	Check LOCAL GAIN control R105, AUDIO RESPONSE switch S104, and seating of P120 (fig. 56).

Step	Test connection	Normal indication	Procedure
6	Headset or speaker to TB163, terminals 10 and 13, for steps (6 thru 11). TS-382(*)/U to pin 5 of V604.	Audio signal heard.	Check resistance of T602 windings (para 49).
7	TS-382(*)/U to pin 6 of V602B.	Volume increases.	Check C605 and circuit components of V604.
8	TS-382(*)/U to pin 8 of V601B.	Volume less than in step 7.	Check LINE GAIN control R104 (fig. 56), C 607, and circuit components of V602B.
9	TS-382(*)/'U to pin 1 of V601A.	Volume same as step 8.	Check C602.
10	Turn AUDIO RESPONSE switch to SHARP.	Volume same as in step 9.	Check FL601 (fig. 51).
11	TS-382(*)/U to pin 2 of V507A.	Volume increases.	Check C549, seating of P112, (fig. 36) and circuit components of V601A.
12	TS-382(*)/U to pin 3 of V507A, then to pin 6 of V507B.	Volume same as in step 11 for both connections.	Check circuit components of V507 (fig. 38 and 40).

(2) *If. tests*.

Step	Test connection	Normal indication	Procedure
	Note: Connect headset or speaker to TB103 LINE AUDIO terminals 10 and 13. Use modulated 455-kc signal from AN/URM-25 (*) for all tests in this subparagraph.		
1	Pin 5 of V504.	Audio signal heard.	Check resistance of windings of T503 and L502 (para49).
	Note: Turn FUNCTION switch to MGC and RF GAIN control to 10.		
2	Pin 1 of V504.	Large increase in volume.	Check circuit components of V504 (fig. 38 and 39).
3	Pin 1 of V503.	Large increase in volume.	Check GAIN ADJ control R519 (para 73) and circuit components of V503 (fig. 38 and 39).
4	Pin 1 of V502	Large increase in volume.	Check circuit components of V502 (fig. 38 and 39).
5	Pin 1 of V501.	Large increase in volume.	Check circuit components of V501.
6	Turn BANDWIDTH switch from 2 thru 16 kc. Listen to audio signal at each position.	Volume about same as in step 5 for each position.	If volume decreases in one of BANDWIDTH switch positions, check BANDWIDTH switch S501. If S501 is not defective, replace appropriate mechanical if. filter (para 64b).
7	Pin 1 of V204.	Volume about same as in step 6.	Check seating of P218, P213 (fig. 36), and resistance of T208 windings (para 49).

(3) *Mixers, oscillators, and rf amplifier tests* (fig. 43).

Step	Test connection	Normal indication	Procedure
	Note: Plug headset into PHONES jack on receiver front panel. Use AN/URM-25 (*) for all tests in this subparagraph.		
1	Connect antenna to test point E211. Apply strong unmodulated 2,455-kc signal to pin 7 of V204. Set receiver frequency indicator at 01 +000.	Noise or signal heard.	Check V204 circuit components; use voltage and resistance diagram (fig. 58).
2	Disconnect antenna. Apply modulated 2-mc signal to test point E211 (fig. 43).	Audio signal heard.	Check VFO output (para 44). Check V701 circuit; use voltage and resistance diagram (fig. 61). Check Z702 resistance (para 49).
3	Apply modulated 2-mc signal to pin 1 of V203.	Volume about same as in step 2.	Check resistance of Z216-1 thru Z216-3 (para 49). Check mechanical and electrical alignment of Z216-1 thru Z216-3 (para 70 and 75).
	Note: Set receiver frequency indicator to 00 500 for steps 4 thru 11.	Noise or signal heard.	Check V203 components; use voltage and resistance diagram (fig. 58).
4	Connect antenna to test point E210 (fig. 43). Apply strong unmodulated 20-mc signal to pin 7 of V203.		
5	Disconnect antenna. Apply modulated 17.5-mc signal to test point E210.	Audio signal heard.	Check V401 output (para 44). Check T401 resistance (para 49). Check V401 circuit components; use voltage and resistance diagram (fig. 59). Check synchronization of crystal-oscillator subchassis. (para 70*e*).
6	Apply 17.5-mc modulated signal to pin 1 of V202.	Volume about same as in step 5.	Check resistance of Z213-1 thru Z213-3 (para 49). Check mechanical and electrical alignment Z213-1 thru Z213-3 (para 70 and 76).
7	Connect antenna to test point E209. Apply strong unmodulated 17-mc signal to pin 7 of V202.	Noise or signal heard.	Check V202 circuit components; use voltage and resistance diagram (fig. 58).
8	Disconnect antenna. Apply 0.5-mc modulated signal to test point E209.	Audio signal heard.	Check for V207 output (pars 44). Check resistance of T207 (para 49). Check V207 circuit components; use voltage and resistance diagram (fig. 58).
9	Apply modulated 0.5-mc signal to test point E209.	Volume about the same as in step 8.	Check 8206 and S207 (fig. 44). Check V201 circuit components; use voltage and resistance diagram (fig. 58).

Step	Test connection	Normal indication	Procedure
			Check mechanical and electrical alignment of Z201-1 thru Z206-1, and Z201-2 thru Z206-2 (para 70 and 77).
10	Apply modulated 0.5-mc signal to test point E208.	Volume greater than in step 9.	Check V201 circuit components; use voltage and resistance chart (fig. 58).
11	Apply modulated 0.5-mc signal to BALANCED or UNBALANCED antenna connector on receiver rear panel.	Volume about the same as in step 10.	Check antenna relay K101 (para 52). Check S201 thru S205 (fig. 44). Check mechanical and electrical alignment of T201 thru T206 (para 70 and 77).

48. Stage-Gain Charts

Use the stage-gain charts as standards when localizing trouble to a stage. These tests *supplement* the trouble shooting (para 46) and signal substitution (para 47) procedures. To make connections where test jacks are not provided, use tube adapters (para 39a). Preset the receiver controls (para 36).

a. Af Tests (fig. 62). For the af tests, measure the signal input level required to produce the output listed in the chart below. For each step, measure the voltage output of the TS-382(*)/U with the ME30(*)/U. Set the TS-382(*)/U to 400 cps for all af tests. Connect the ground lead of the TS-382(*)/U to the receiver chassis ground and connect the hot lead, through a 0.05 uf, 400-volt capacitor, to the specified test point. The chart below lists the test instructions, the signal input voltage, and the output voltage for a normal receiver.

Step	Test instructions	TS-382(*)/U output level (volts rms)	Receiver output level (volts rms)
1	Connect ME-30/U and 600-ohm, 1-watt carbon resistor in parallel between TB102 LOCAL AUDIO terminals 6 and 7 on the receiver rear panel; connect TS-382(*)/U to pin 1 of V603; preset receiver controls (para 36) but turn RF GAIN control to 0; turn LOCAL GAIN control to 10; turn FUNCTION switch to MGC.	10	17.3
2	Connect TS-382(*)/U to pin 1 of V602A.	0.60	17.3
3	Connect TS-382(*)/U to pin 7 of V601B.	1.6	17.3
4	Connect TS-382(*)/U to TB103 DIODE LOAD terminal 14.	1.0	17.3
5	Connect ME-30(*)/U and 600-ohm, 1-watt carbon resistor, in parallel, between TB103 LINE AUDIO terminals 10 and 13. Turn LINE GAIN control to 10. Connect TS-382 (*)/U to pin 1 of V604.	10	2.45
6	Connect TS-382(*)/U to pin 7 of V602B.	0.60	2.45

Note: Be sure that GAIN ADJ R519 is properly adjusted (para 73) before making the if. stage-gain test.

b. If. Tests. For the if. tests, connect the COMMON lead of the TS-505(*)/U to the receiver chassis ground and connect the hot lead to TB103 terminal 14 on the receiver rear panel. Turn the TS-505(*)/U FUNCTION switch to -DC and the RANGE switch to 10V. Connect Test Lead CX-2919/U (part of the AN/URM-25D or AN/URM-25F) between receiver chassis ground and the test point indicated in the chart below. Preset the receiver controls (para 36) but turn the RF GAIN control to 10 and the FUNCTION switch to MGC. Set the AN/URM-25(*) to 455 kc, and then retune it slightly for a maximum TS505(*)/U indication. The chart below lists the test connections and the AN/URM25(*) output level required to produce a-7 volt TS-505(*)/U indication.

Test connections (fig. 60)	AN/URM-25(*) output (microvolts)
Connect the AN/URM-25(*) to:	
Pin 1 of V504	100,000[a]
Pin 1 of V503	10,000 to 20,000
Pin 1 of V502	250 to 500
Pin 1 of V501	100 to 200

[a] The TS-505(*)/U indication will be -4 volts.

c. Rf Tests. For the rf tests, use the same setup as in *b* above. The chart below lists the test connections, the frequency range for each test, and the AN/URM25(*) level required to produce a -7-volt TS-505(*)/U indication.

Test connection (fig. 43)	Frequency range (mc)	AN/URM-25(*) output (microvolts)
Connect the AN/URM-25(*) to test point:		
E210	17.5 to 25	20 to 60
	3 to 2	13 to 40
	8 to 32	20 to 65
E209	0.5 to 8	15 to 60
	17.5 to 25	15 to 60
E208	0.5 to 32	4 to 16
BALANCED antenna connector	0.5 to 32	1 to 4

49. Dc Resistances of Transformers and Coils

The dc resistances of the windings of the transformers and coils in Radio Receiver R-390A/URR as measured with Multimeter TS-352(*)/U, or equivalent, are listed in *a* through *f* below:

a. Main Frame.

Transformer or coil	Terminals	Ohms
FL101	A-A	Less than 0.1
	B-B	Less than 0.1
K101	1-2	200

b. Rf Subchassis.

Transformer or coil	Terminals	Ohms
HR202	1-3	5
L201		7
L202		0.6
L203		0.6
L204		0.6
L205		0.6
L206		0.6
L207		0.6
L208		7
L210		0.15
L211		7
L236		0.3
T201	1-2	Less than 0.2
	4-6	2.7
T202	1-2	Less than 0.2
	4-6	1.2
T204	1-2	Less than 0.2
	4-6	4
T205	1-2	Less than 0.2
	4-6	Less than 0.2
T206	1-2	Less than 0.2
	4-6	Less than 0.2
T207	1-2	Less than 0.2
	3-4	Less than 0.2
T208	1-5	2.5
	2-3	2
	3-4	2
	2-4	4
Z201-1	1-3	2.8
Z202-1	1-3	1.8
Z203-1	1-3	1.2
Z204-1	1-3	0.5
Z205-1	1-3	0.2
Z206-1	1-3	Less than 0.2
Z201-2	1-3	2.8
Z202-2	1-3	1.8
Z203-2	1-3	1.2
Z204-2	1-3	0.5
Z205-2	1-3	0.2
Z206-2	1-3	Less than 0.2
Z213-1	1-3	Less than 0.2
Z213-2	1-3	Less than 0.2
Z213-3	1-3	Less than 0.2
Z216-1	1-3	1.1
Z216-2	1-3	1.1
Z216-3	1-3	1.1

c. Crystal-Oscillator Subchassis.

Transformer or coil	Terminals	Ohms
HR401	Gnd J410-E	11
L401		7
L402		0.6
T401	1-2	Less than 0.1
	3-4	Less than 0.1

d. If. Subchassis.

Transformer or coil	Terminals	Ohms
FL502	1-2	40
	3-4	40
FL503	1-2	40
	3-4	40
FL504	1-2	40
	3-4	40
FL505	1-2	40
	3-4	40
L501		7
L502		90
L504		3
L505		90
RT510	2-7	8
T501	1-2	6
	4-5	6
T502	1-2	6
	4-5	6
T503	1-2	6
	3-4	6.1
	4-5	6.3
	3-5	0.2
Z501	1-2	4.8
Z502	1-2	0.2
	1-3	1.8
	2-3	1.6
Z503	1-5	18

e. Af Subchassis.

Transformer or coil	Terminals	Ohms
FL601	1-2	230
	2-3	250
	1-3	480
K601	1-7	2.8
L601	1-2	130
L602	1-2	125
L603	1-2	110
RT510	2-7	8
T601	1-2	580
	3-4	28
	5-6	30
T602	1-2	580
	3-4	28
	5-6	30

f. Vfo Subchassis.

Transformer or coil	Terminals	Ohms
L706		0.6
Z702	1-2	4
	3-4	0.5

50. Internal Frequency and Switch Settings

a. The position of switches S201 and S401 and the frequency of the rf and variable if. stages is changed automatically as the receiver is tuned through various frequency bands. The chart below lists the switch positions and the corresponding frequencies for the first variable if. and the second crystal oscillator for every 1-mc increment of the receiver tuning range. Refer to paragraph 4 for complete frequency conversion details.

b. Rf and variable if. conversion scheme is listed in the chart below:

Band (mc)	Position of switch S201 and range of antenna and rf coils (mc)	Position of switch S401	1st variable if range (mc)	2d xtal-osc crystal freq (mc)	2d xtal-osc output freq (mc)
0.5-1	0.5-1	0.5	17.5-18	10.0	20.0
1-2	1-2	1	18-19	10.5	21.0
2-3	2-4	2	19-20	11.0	22.0
3-4	2-4	3	20-21	11.5	23.0
4-5	4-8	4	21-22	12.0	24.0
5-6	4-8	5	22-23	12.5	25.0
6-7	4-8	6	23-24	13.0	2(;.0
7-8	4-8	7	24-25	9.0	27.0
8-9	8-16	8	Not used	11.0	11.0
9-10	8-16	9	Not used	12.0	12.0
10-11	8-16	10	Not used	13.0	13.0
11-12	8-16	11	Not used	14.0	14.0
12-13	8-16	12	Not used	15.0	15.0
13-14	8-16	13	Not used	16.0	16.0
14-15	8-16	14	Not used	17.0	17.0
15-16	8-16	15	Not used	9.0	18.0
16-17	16-32	16	Not used	9.5	19.0
17-18	16-32	17	Not used	10.1	20.0

Band (mc)	Position of switch S201 and range of antenna and rf coils (mc)	Position of switch S401	1st variable if range (mc)	2d xtal-osc crystal freq (mc)	2d xtal-osc output freq (mc)
18-19	16-32	18	Not used	10.5	21.0
19-20	16-32	19	Not used	11.0	22.0
20-21	16-32	20	Not used	11.5	23.0
21-22	16-32	21	Not used	12.0	24.0
22-23	16-32	22	Not used	12.5	25.0
23-24	16-32	23	Not used	13.0	26.0
24-25	16-32	24	Not used	9.0	27.0
25-26	16-32	25	Not used	14.0	28.0
26-27	16-32	26	Not used	14.5	29.0
27-28	16-32	27	Not used	15.0	30.0
28-29	16-32	28	Not used	15.5	31.0
29-30	16-32	29	Not used	16.0	32.0
30-31	16-32	30	Not used	11.0	33.0
31-32	16-32	31	Not used	17.0	34.0

51. Checking Oven Thermostats

Use the TS-352(*)/U to check the thermostats in the crystal ovens. The receiver should be turned off at least 1 hour before these tests (*a* and *b* below) are performed.

a. Oven HR202 (fig. 43).

(1) Disconnect P108 (fig. 56) from J208 and measure the resistance between chassis ground and pin F on J208. The resistance should be approximately 100 ohms. This indicates that the thermostat switch is closed.

(2) Set the TS-352(*)/U for ac measurements. Connect the meter leads between chassis ground and pin 1 of HR202. (Use a tube test-point adapter to gain access to pin 1 of HR202.)

(3) Reconnect P108 and J208, set the FUNCTION switch to AGC or MGC, and turn the receiver on. Allow a 10-minute warmup period.

(4) The meter indication should change from 0 to 6.3 volts ac as the oven turned on and off, which indicates that the thermostat is operating.

b. Ovens HR401 and HR701.

(1) Turn OVENS switch S106 (fig. 37) to OFF. Connect a 1-ohm, 4-watt resistor across the terminals of S106.

(2) Connect the TS-352(*)/U leads across the 1-ohm resistor to monitor the ac voltage drop across the resistor.

(3) Set the receiver FUNCTION switch to AGC or MGC to turn the receiver on. Allow a 10-minute warmup period.

(4) The TS-352(*)/U should indicate zero when both thermostats open, and approximately 2-volts for each oven when they operate. A 4-volt reading indicates that both ovens are functioning normally.

52. Checking Relays K101 and K601

If the operating condition of antenna relay assembly K101 (fig. 36) or break-in relay K601 (fig. 51) is doubtful, check it as follows:

a. K101.

(1) Check the resistance of K101 (para 49). Also check selenium rectifier CR102 (para 53b).

(2) Disconnect P205 from J105, P206 from J106, and P207 from J107 (fig. 36).

(3) Connect the receiver to the power source.

(4) Turn the FUNCTION switch to STAND BY.

(5) Check for zero resistance between each terminal of BALANCED antenna connector J104, and between UNBALANCED antenna connector J103 terminal and chassis ground.

(6) Turn the FUNCTION switch to AGC.

(7) Check between J107 and each terminal of J104 for continuity. One of the tests should indicate 0 ohms and the other

should indicate infinite resistance. Repeat this test for J106.

(8) Check between P205 and J103 for 0 ohms.

(9) If the indications do not meet the requirements of the procedures given in (5), (7), and (8) above, replace K101.

b. K601.

(1) Connect the receiver to the power source, and turn the FUNCTION switch to STAND BY.

(2) Turn the BREAK IN switch to ON.

(3) Check for 6.3 volts ac between terminal 9 of TB103 (receiver rear panel) and chassis ground.

(4) If the voltage ((3) above) is not present, disconnect P119 (fig. 37) from J619. Check between P119-10 and chassis ground for 6.3 volts ac.

(5) If 6.3 volts ac is present ((4) above), check break-in switch S103 (fig. 56). If S103 is good, remove the af subchassis (TM 11-5820-358-20) and check K601 by substitution.

53. Checking Rectifiers CR101 and CR102
(fig. 56)

a. Check CR101 by measuring the crystal forward and reverse resistance with the TS-352(*)/U. Proceed as follows:

(1) Measure and record the resistance between TB102 terminals 4 and 5.

(2) Reverse the TS-352(*)/U test leads. Measure and record the resistance between TB102 terminals 4 and 5.

(3) The ratio of the resistances recorded in procedures (1) and (2) above must be at least 50 to 1.

b. Check selenium rectifier CR102 by measuring the ac input voltage and the dc output voltage with the TS-352(*)/U. Proceed as follows:

(1) Turn the FUNCTION switch to CAL.

(2) Turn the OVENS switch to ON.

(3) Measure the ac voltage between chassis ground and the yellow lead on CR102. The TS-352(*)/U reading should be approximately 25.2 volts ac.

(4) Measure the dc voltage between the red and blue terminals of CR102. It must be at least 19 volts dc.

(5) If the resistance of K101 (para 52a) is normal and the requirement in procedure (4) above is not met, replace CR102.

54. Checking Lamp I103
(fig. 55)

Lamp I103 can be checked by the application of 90 volts dc or 65 volts ac across its terminals. This is the minimum voltage required to make it light.

55. Main-Frame Continuity Chart

Use the main-frame wiring diagram (fig. 87) and the chart below when tracing wires in the main frame of the receiver. The From and To columns indicate wire continuity. The *Notes* column gives additional information, such as wire color and ground connections.

Note: Items 6, 52, 53, 54, and 58 do not apply to receivers bearing Order No. 14-Phila-58, serial numbers 2683 and above, and all receivers on Order No. 14385-Phila-58.

Item	From	To	Notes
1	S101-3	P112-11	White-green
2	S101-2	S102-2B	White-red
3	S102-B	F101-2	White-orange
4	S102-A	P111-7	White-orange
5	S102-8B	P119-3	White-red-blue
6	S102-1B	P119-2	White-red-green
7	S102-2B	P112-2	White-red
8	S102-4B	P108J	White-black-green
9	S102-5B	P119-8	White-black-red

Item	From	To	Notes
10	S102-7B	P119-4	White-brown-red
11	S102-8F	P119-7	White-red-orange-blue
12	S102-5F	TB102-3	White-orange
13	S102-6F	R103-1	White
14	S103-3	TB103-9	White-brown-red-orange
15	S103-2	P119-1	White-black-red-orange
16	S104-1	P120-6	Shielded wire, black
17	S104-2	P120-5	Shielded wire, red
18	S104-4	R104-1	White-black
19	S104-6	P120-15	Shielded wire, yellow
20	S104-7	P120-4	Shielded wire, green
21	S104-8	P120-7	Shielded wire, brown
22	S105-8	TB101-7	White-green-blue
23	S105-7	TB101-3	White-blue
24	S105-4	TBI01-9	White-brown-blue
25	S105-3	TB101-11	White-black-blue
26	S105-10	TB101-10	White-black-red-green
27	S105-9	TB101-12	White-black-red-blue
28	S107-9	S108-6	White
29	S107-8	P112-15	White-orange-green
30	S107-7	P112-13	White-red-orange-green
31	J102-2	TB102-8	Shielded wire, white-blue
32	J102-1	TB102-7	Shield, white
33	S108-7	P112-10	White-orange-blue
34	S108-5	P112-9	White-red-orange
35	R120-3	TB103-15	Shielded wire, orange
36	R120-1	TB103-16	Shield
37	R104-1	R105-1	Shielded wire, white-black
38	R104-3	R105-3	Shield
39	R104-2	P120-3	Shielded wire, white-orange
40	R104-3	P120-13	Shield
41	R105-1	P120-2	Shielded wire, white-black
42	R105-3	P120-13	Shield
43	R105-2	P120-1	Shielded wire, white
44	R105-3	P120-13	Shield
45	R103-1	MF grd-34	Main-frame, ground, white
46	R103-2	TB102-2	White-brown-green
47	M101 (+)	TB101-8	White-black-orange
48	M102 (+)	P112-14	White-black-orange
49	M102 (-)	P112-12	White-brown-orange
50	TB101-1	P119-10	White-black
51	I101-C	MF grd-32	Main-frame ground, white
52	P119-2	P109-A	White-red
53	P119-2	P110-A	White-red
54	P119-2	P108-K	White-red-green
55	P119-4	P109-B	White-brown-red
56	P119-4	P108-D	White-brown-red
57	P119-4	P110-C	White-brown-red
58	P119-5	P111-5	White-red
59	P119-6	CR102-Y2	White-brown
60	P119-9	TB102-6	White-green
61	P119-10	P111-10	White-black
62	P119-11	MF grd-34	Main-frame ground, white
63	P120-8	M101 (+)	White-black-orange
64	P120-9	TB103-11	White-black-blue
65	P120-10	TB103-12	White-brown-blue
66	P120-11	TB103-14	Shielded wire, white-brown
67	P120-13	TB103-16	Shield

Item	From	To	Notes
68	P120-12	TB101-4	White-green
69	P120-13	MF grd-34	Main frame ground, white
70	P120-14	P112-7	Shield
71	P120-13	P112-17	Shield
72	P109-D	S106-ON	White-brown
73	P109-E	S106-ON	White-brown
74	P109-F	MF grd-34	Main-frame ground, white
75	P109-H	P112-19	White-black-blue
76	P109-J	MF grd-34	Main-frame ground, white
77	P109-K	MF grd-34	Main-frame ground, white
78	P111-1	P112-8	White-brown
79	P111-1	S106-OFF	White-brown
80	P111-2	MF grd-33	Main-frame ground, white
81	P111-6	FL101-A	White-orange
82	P111-10	P112-20	White-black
83	P111-11	MF grd-33	Main-frame ground, white
84	TB103-10	TB101-6	White-red-blue
85	TB103-13	TB101-5	White-black-red
86	TB103-14	P112-5	Shielded wire, white-brown
87	TB103-16	P112-17	Shield
88	TB103-15	P112-3	Shielded wire, orange
89	TB103-16	P112-17	Shield
90	TB103-16	MF grd-33	Main-frame ground, white
91	C103 (+)	P112-16	White-blue
92	C103 (-)	MF grd-32	Main-frame ground, white
93	P108-H	MF grd-33	Main-frame ground, white
94	TB102-1	C103 (+)	White-blue
95	TB102-3	P112-4	White-orange
96	TB102-4	P112-6	White-black-red
97	TB102-7	MF grd-33	Main-frame ground, white
98	P112-2	P108-A	White-red
99	P112-16	P108-C	White-blue
100	S106-ON	P110-E	White-brown
101	S106-ON	P110-F	White-brown
102	P112-17	MF grd-32	Main-frame ground, white
103	P112-18	MF grd-32	Main-frame ground, white
104	P112-20	P110-B	White-black
105	P112-20	P108-B	White-black
106	P112-20	P108-F	White-brown
107	P112-6	P 108-E	White-black-red
108	P110-D	MIF grd-32	Main-frame ground, white
109	P119-11	MF grd-32	Main-frame ground, white
110	CR102-Y1	S106-OFF	White-brown
111	CR102 (-)	K101-1	White-black-red-green
112	CR102 (+)	K101-2	White-black-red-blue
113	P111-3	P111-4	Jumper
114	M101	8105	White-red
115[a]	S102-1B	F103-2	White-red-green
116[a]	F103-2	P109-A	White-red
117[a]	F103-2	P110-A	White-red
118[a]	F103-2	P108-K	White-red-green
119[a]	P119-2	F103-1	White-red
120[a]	P119-5	F102-2	White-red
121[a]	P111-5	F102-1	White-red

[a] Apply to receivers bearing the listed order numbers. All other items in the chart apply to all receivers.

56. Resistance Measurements at Subchassis Connectors

Connectors are used in this receiver to interconnect the various subchassis. Defects may be localized by measurement of the resistance to ground at the receptacle terminals of a subchassis. The charts below indicate the normal resistance between the indicated receptacle terminals and chassis ground. To prepare the receiver for these measurements, disconnect the receiver from the power source and remove the connectors from the subchassis suspected to be faulty.

a. Rf Subchassis (fig. 43).

Terminal of receptacle J208	Resistance to ground (ohms)
A	92K
B	0.8
C	Inf
D	Inf
E	Inf
F	100
H	0
J	Inf
K	Inf

b. Crystal -Oscillator Subchassis (fig. 46)

Terminal of receptacle J410	Resistance to ground (ohms)
A	Inf
B	10
C	Inf
D	0
E	11
F	11
H	0

c. If Subchassis (fig. 38).

Terminal of receptacle J512	Resistance to ground (ohms)
1	Inf
2	50K
3	54K
4	500K
5	Inf
6	Inf
7	Inf
8	Inf
9	Inf
10	440K
11	Inf
12	27
13	Inf
14	0 to 20
15	132K
16	100K
17	0
18	0
19	Inf
20	0.5

d. Af Subchassis (fig. 51).

Terminal of receptacle J619	Resistance to ground (ohms)
1	3.6
2	90K
3	90K
4	90K
5	90K
6	Inf
7	Inf
8	Inf
9	58
10	Less than 0.1
11	0
Terminal of receptacle J620	Resistance to ground (ohms)
1	Inf
2	940K
3	Inf
4	470K
5	200
6	Inf
7	200
8	Inf
9	Inf
10	Inf
11	Inf
12	Inf
13	0
14	1.36 meg
15	Inf

e. Vfo Subchassis (fig. 49).

Terminal of receptacle J709	Resistance to ground (ohms)
A	Inf
B	Inf
C	Inf
D	Inf
E	Inf
F	0
H	3.5
J	Inf
K	Inf

f. Power Supply Subchassis (fig. 53).

Terminal of receptacle J811	Resistance to ground (ohms)
1	Less than 0.1
2	0
3	Inf
4	Inf
5	Inf
6	Inf
7	Inf
8	Inf
9	Inf
10	Less than 0.1
11	0

Section III. REPAIRS

57. Notes on Removals and Replacements

a. General. This section gives instructions for the removal and replacement of the subchassis, the subassemblies, and certain parts in Radio Receiver R-390A/ URR. Removal and replacement instructions for the power supply and the af subchassis, crystal oven HR202, and the cover of crystal oven HR401 are given in TM 11-5820-358-20. All the subchassis, except the rf subchassis, can be removed from the main frame of the receiver without removal of the front panel or other subassemblies in the receiver. *Avoid changing the setting* of the KILOCYCLE CHANGE control or any of the switches or shafts operated by the MEGACYCLE CHANGE control when the rf, the if., and the vfo subchassis are operated out of the receiver main frame. If these controls must be operated, reset them to their previous settings.

b. Captive and Mounting Screws. All the threaded fasteners that secure the subassemblies to the main frame of the receiver are color coded with green screwheads. Loosen and remove only these screws unless otherwise instructed. The only exceptions to the use of the green-headed screws are the front-panel screws that secure the front panel of the receiver (fig. 65). Some of the securing screws are the conventional threaded type, and the remainder are captive screws. Captive screws remain attached to the subassembly that they secure when the subassembly is removed from the main frame. All captive and mounting screws are loosened and removed with the Phillips screwdriver supplied with the receiver. All knobs, shaft couplers, gears, and cams are loosened and removed with the No. 8 Bristo (fluted) wrench supplied with the receiver.

c. Connectors. All rf and power connectors used in the receiver are readily removed by hand. The rectangular power connectors are removed by being pulled outward with a slight rocking motion. The polygon-shaped power connectors have locking shells that must be rotated counterclockwise before being removed from their mating connectors. The coaxial rf type connectors also must be rotated counterclockwise before being removed from their mating connectors. In several cases, the removal of an rf connector can be made easier by the use of long-nosed pliers. When replacing the connectors, be careful not to bend or break the connector pins. Examine the pins on the connectors before attempting to join them with their mating connectors. This will indicate the proper pin alignment and reveal damaged pins.

d. Receiver Handling. The use of two wooden blocks, about 2 inches thick and 12 inches long, is necessary for supporting the main frame of the receiver when it is placed on a bench or table. Place the wooden blocks under the bottom side edges of the receiver. This allows the front panel to be removed and rested on its handles.

e. Storing Disassembled Parts. Place all small parts in trays or containers to prevent damage or loss.

58. Removal and Replacement of Front Panel

(fig. 65 and 56)

a. General. The front panel must be removed whenever the removal of the rf subchassis and its rf gear train assembly is required. Follow the procedures in the order listed in b below to prevent damage or mechanical misalignment of the tuning system.

b. Removal.

(1) Remove the top and bottom dust covers if they were not removed during installation.

(2) Place the receiver on the wooden blocks (para 60d).

(3) Turn the DIAL LOCK fully counter-clockwise.

(4) Turn the KILOCYCLE CHANGE control knob fully counterclockwise (approximately -963 on the kilocycle counter).

(5) Turn the MEGACYCLE CHANGE control knob fully counterclockwise (approximately 00 on the megacycle counter).

(6) Set the BFO PITCH and the ANT TRIM knobs to 0, and the BANDWIDTH switch to 16.

(7) Use the No. 8 Bristo wrench to remove the MEGACYCLE CHANGE, KILOCYCLE CHANGE, ANT TRIM, and DIAL LOCK control knobs.

(8) Use a 1/2-inch socket wrench to loosen the hexagonal nut on the DIAL LOCK shaft, turn the DIAL LOCK mechanism (fig. 56) behind the front panel (to disengage it) so that it is in a vertical position, and handtighten the hexagonal nut.

(9) Use the No. 8 Bristo wrench to loosen, but do not remove the BFO PITCH shaft coupler. Grasp the BFO PITCH control knob and pull it outward from the front panel to separate the knob shaft and coupler from the BFO PITCH shaft.

(10) Use the No. 8 Bristo wrench to loosen the BANDWIDTH shaft coupler, and pull the knob and shaft outward.

(11) Remove the four 5/8-inch by 8-32 flat Phillips-headscrews on the left side of the front panel. These screws are vertical and in line with the left front-panel handle. Remove the four similar screws on the right side of the front panel. Remove the five 7/16-inch by 6-32 flat Phillips screws and the external tooth lockwashers on the front panel.

(12) Grasp the front-panel handles and pull forward with a slight vertical rocking motion. (See caution note below.) The front panel will separate from the main frame, while riding on the shafts of the KILOCYCLE CHANGE, the MEGACYCLE CHANGE, and the ANT TRIM controls.

***Caution*: Be sure that the DIAL LOCK mechanism does not bind on the riveted locking plate mounted on the KILOCYCLE CHANGE shaft.**

(13) Carefully lower the front panel to the bench top; rest it on its handles.

c. Replacement.

(1) Check to see that the DIAL LOCK mechanism is in a vertical position and that the ZERO ADJ knob is fully counterclockwise.

(2) Grasp the front panel by the two handles and slide it forward onthe KILOCYCLE CHANGE, the MEGACYCLE CHANGE, and the ANT TRIM shafts with a slight vertical rocking motion, while pushing forward.

(3) Grasp the DIAL LOCK shaft and rotate the mechanism so that its jaws loosely clutch the riveted locking plate on the KILOCYCLE CHANGE shaft. Set the mechanism in the position that allows the raised surface on the mechanism to fall into the aligning dimple on the rear side of the front panel.

(4) Replace and secure the front panel with the eight 5/8-inch by 8-32 screws and the five 7/16-inch by 6-32 screws and the five lockwashers.

(5) Tighten the DIAL LOCK hexagonal nut with a 1/2-inch socket wrench. Replace the knob, allowing a 1/8 inch clearance between the knob and the front panel.

(6) Replace the remaining knobs on their respective shafts. Allow a 1/8-inch clearance between the front panel and the MEGACYCLE CHANGE and the KILOCYCLE CHANGE control knobs.

(7) Engage and tighten the shaft couplings on the BANDWIDTH and BFO PITCH controls. Be sure that the BANDWIDTH control knob is tightened on the 16 position and that the BFO PITCH control and the ANT TRIM knobs are tightened to 0.

(8) Turn all the knobs previously removed through their entire range, and check for smoothness of operation and freedom from binding.

59. Removal and Replacement of Rf Subchassis
(fig. 66)

a. General. Remove the rf subchassis and the crystal-oscillator subchassis as one unit. To remove the crystal-oscillator subchassis from the rf subchassis after both have been removed from the main frame, follow the instructions given in paragraph 60.

b. Removal. To remove the rf and crystal-oscillator subchassis, proceed as follows:

(1) Place the receiver on its left side and remove the antibacklash spring from the Oldham coupler (fig. 49 and 70) on the vfo assembly.

(2) Remove the front panel (para 58).

(3) Remove the rf subchassis cover plate.

(4) Disconnect plugs P110, P205, P206, P207, P717, P213, P218, and P108 (fig. 36).

(5) Remove the two 5/16-inch by 6-32 Phillips green-headed screws and lockwashers (fig. 67). One of the screws is removable through an access hole in the front gearplate.

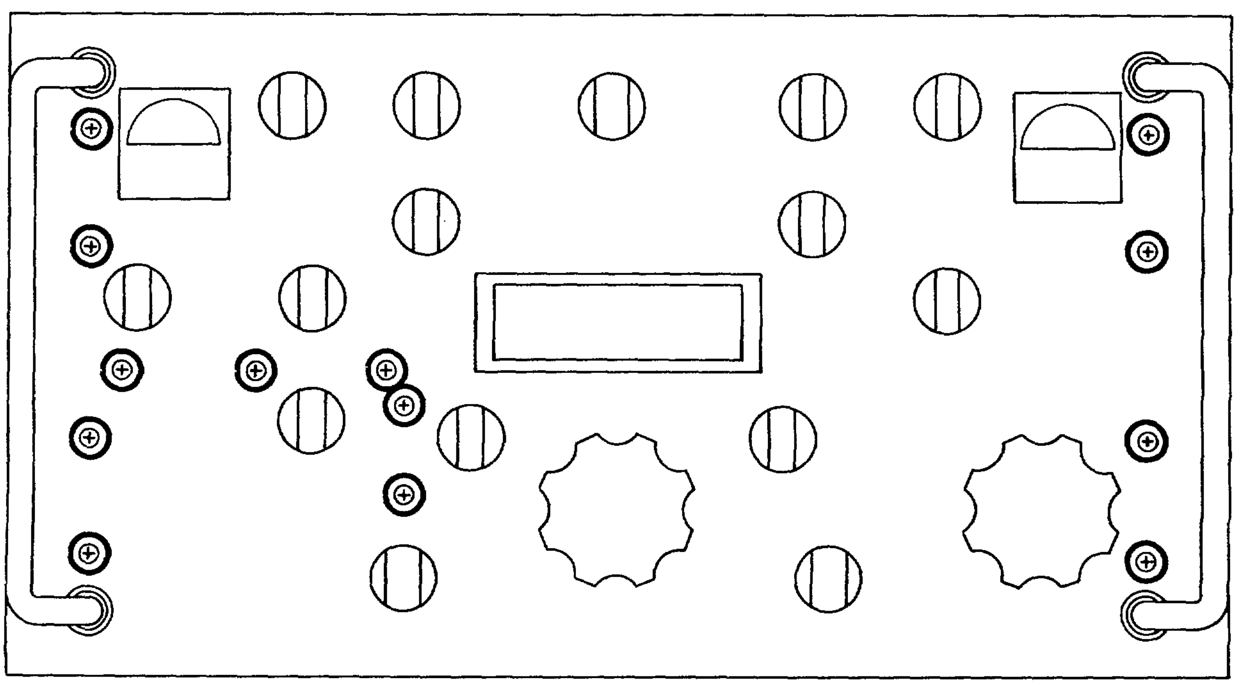


Figure 65. Front-panel removal and replacement, location of panel-mounting screws.

(6) Remove the two 1/2-inch by 6-32 Phillips green-headed screws and lockwashers ((1), fig. 66) through the access hole provided in the left side of the main frame. These two screws are in a vertical row.

(7) Remove the three 1/2-inch by 6-32 Phillips green-headed screws and lockwashers ((2), fig. 66) that are located at the right side of the main frame. These three screws are in a vertical row.

(8) Loosen the two green-headed captive screws ((3), fig. 66) and the two green headed captive screws ((4), fig. 66).

Caution: Check to see that the plugs listed in procedure (4) above are disconnected.

(9) Turn the KILOCYCLE CHANGE shaft fully counterclockwise against the stop.

Caution: During the performance of the next step, the Oldham coupler on the vfo subassembly shaft will come apart and the center disk will fall to the bench. Pick up the center disk and place it with the Oldham coupler antibacklash spring for safekeeping.

(10) Grasp the rf subassembly by the two 5-5/8-inch spacers and lift it carefully upward out of the main frame. Place the rf subchassis on the bench. Remove the crystal oscillator subassembly only when necessary (para 60).

c. Replacement. These instructions are for replacement of the rf subchassis with the crystal-oscillator subchassis attached. If the crystal-oscillator subchassis has been removed from the rf subchassis, secure it to the rf subchassis (para 60).

Caution: Before reinstalling the subchassis, be sure that the KILOCYCLE CHANGE shaft is fully counterclockwise.

(1) If the center disk of the Oldham coupler has been removed, apply a little grease (TM 11-5820-358-20) on it and place it on the end disk attached to the vfo subchassis shaft.

(2) Grasp the rf subchassis by the two 5-5/8-inch spacers and place it into the main frame. Retain the rf subchassis in place by replacing, but not tightening, one or two of the Phillips green-headed machine screws and their lockwashers. Leaving these screws loose allows shifting of the subchassis when replacing the other screws.

Caution: Be careful not to damage the metal grounding strips that contact the bottom edges of the rf and crystal-oscillator subchassis. To prevent damage to the parts on the front panel, temporarily slide the front panel onto the KILOCYCLE CHANGE and the MEGACYCLE CHANGE shafts prior to setting the receiver on its side.

(3) Set the receiver on its left side with two wooden blocks under it and check the fitting of the Oldham coupler on the vfo subchassis. The center disk of the Oldham coupler should join the two end disks with about 1/32-inch play in the coupler (fig. 70).

(4) Engage the two green-headed captive screws ((3), fig. 66) at the rear of the crystal-oscillator subassembly; do not tighten them. Engage, but do not tighten, the two green-headed captive screws ((4), fig. 66) at the rear of the rf subassembly.

(5) Engage the three Phillips greenheaded screws with their lockwashers ((2), fig. 66) and the two Phillips green-headed screws ((1), fig. 66). Engage the two Phillips green-headed screws and lockwashers at the front under the clutch gear and tuning mechanism.

(6) Tighten all the green-headed screws in the following order:

(a) Three marked (2).

(b) Four captive screws marked (3) and (4).

(c) Two marked (1).

(d) Two below the clutch gear (fig. 67).

(7) Reconnect plugs P110, P717, P205, P206, P207, P213, P218, and P108.

(8) Replace the front panel (para 58).

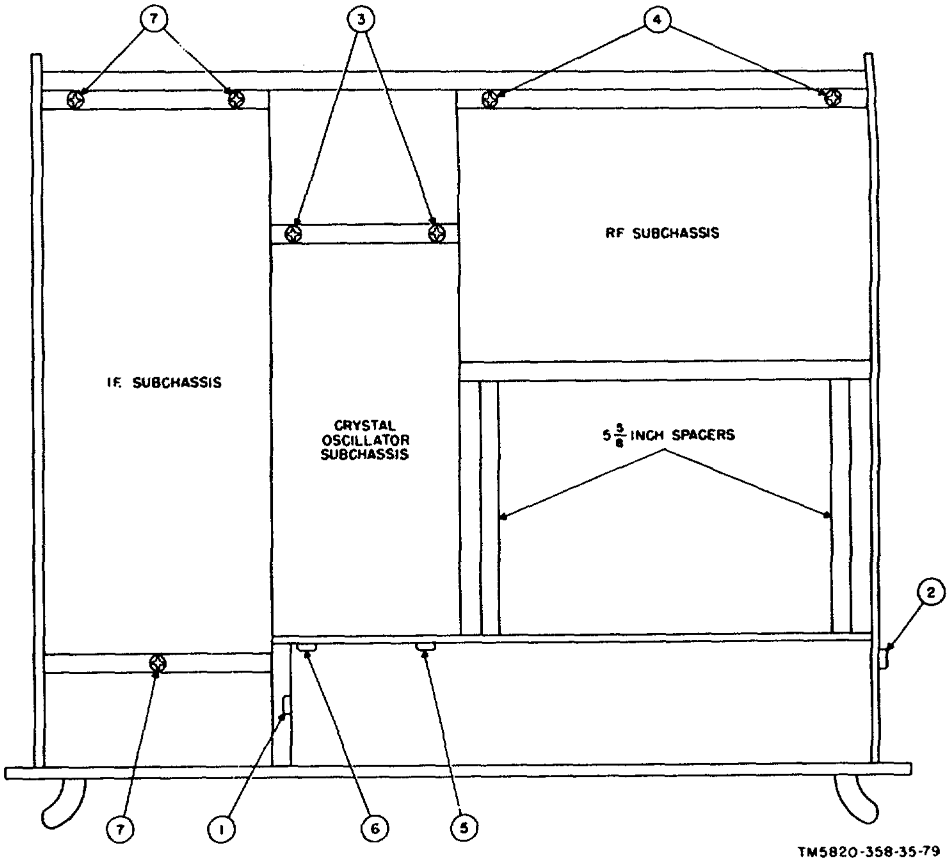


Figure 66. Rf, if., and crystal-oscillator subchassis removal and replacement, location of screws.

60. Removal and Replacement of Crystal Oscillator Subchassis

(fig. 66)

a. General. Two methods can be used for the removal of the crystal-oscillator subchassis. This procedure, however, is for the removal of the crystal-oscillator subchassis when the rf subchassis is to be retained in the main frame of the receiver. When the rf and crystal-oscillator subchassis have been previously removed from the main frame, omit the procedures given in (1), (7), and (9) below.

b. Removal.

(1) Remove the front panel (para 58).

(2) Disconnect plugs P110 and P215 (fig. 36).

(3) Temporarily replace the MEGACYCLE CHANGE knob and turn it until the gears are positioned with their holes lined up with the access hole in the front plate. This makes 5/16-inch by 6/32 Phillips greenheaded screws ((5), fig. 66) accessible.

(4) Remove the screw ((3) above) and its lockwasher and the two greenheaded screws and their lockwashers ((6), fig. 66). The latter two screws are in a vertical row.

(5) Loosen, but do not remove, the shaft coupler setscrew on the crystal-oscillator drive shaft (fig. 36).

(6) Loosen the two green-headed captive screws ((3), fig. 66) at the rear of the crystal-oscillator subchassis.

(7) Temporarily disconnect plugs P205, P206, and P207 (fig. 36) to provide enough clearance for subchassis removal.

Caution: Be careful not to damage the metal grounding strip that contacts

the bottom edges of the rf and the crystal-oscillator subchassis.

(8) Raise the rear end of the subchassis approximately one-fourth inch, slide the subchassis backward, and lift it out of the main frame.

(9) Reconnect plugs P205, P206, and P207.

c. Replacement.

Note: Only even numbers appear on the indicator wheel; odd numbers appear as straight lines; 00 on the frequency indicator appears as 0.

(1) Set the crystal-oscillator subchassis dial indicator to 0 and the first two digits of the frequency indicator to 00. Turn the subchassis over and adjust it (if necessary) for proper mating of the rotor and the fixed contacts of S401 and S402 (fig. 47).

Note: Adjust the crystal-oscillator shaft at the rear of the crystal-oscillator subchassis when the subchassis is mounted in the main frame. This is done with a longshafted screwdriver through the SYNC XTAL OSChole at the rear of the receiver main frame.

(2) Temporarily disconnect plugs P205, P206, and P207 (fig. 36).

Caution: Be careful not to damage the metal grounding strip that contacts the bottom edges of the rf and crystal-oscillator subchassis.

(3) Place the subchassis in position on the deck of the main frame, and carefully slide it forward and engage the drive shaft.

(4) Engage, but do not tighten, the two green-headed captive screws at the rear of the subchassis.

(5) Tighten the setscrew in the shaft coupler on the crystal-oscillator drive shaft, and be sure that the coupler and gear are pushed against the oilite bearing on the subchassis.

(6) Replace the three Phillips greenheaded screws and their lockwashers ((5) and (6), fig. 66) at the front of the crystal-oscillator subchassis. Long-nosed pliers maybe used to hold the screws while starting them.

(7) Tighten the two green-headed captive screws at the rear of the subchassis.

(8) Reconnect plugs P205, P206, P207, P110, and P215.

(9) Replace the front panel (para 58*c*).

61. Removal and Replacement of If. Subchassis

a. General. Removal of this subchassis does not require the removal of other subchassis or parts except for those connectors that connect to the subchassis.

b. Removal.

(1) Set the BANDWIDTH switch to 16 and the BFO PITCH control to 0.

(2) Disconnect plugs P112, P116, P213, and P218 (fig. 36).

(3) Loosen the shaft couplers on the BANDWIDTH and BFO PITCH controls (fig. 56). Slide the knobs and shafts outward.

(4) Loosen the three green-headed captive screws ((7), fig. 66) that secure the if. subchassis to the main frame.

(5) Lift the if. subchassis out of the main frame.

Caution: Do not change the settings on the BANDWIDTH and BFO PITCH shafts unless absolutely necessary. If they are moved, reset them when replacing the if. subchassis in the main frame.

c. Replacement. Replace the if. subchassis into the main frame of the receiver as follows:

(1) Set the if. subchassis into the main frame of the receiver.

(2) Engage, but do not tighten, the three green-headed captive screws.

(3) Slide the shafts and couplers of the BANDWIDTH and BFO PITCH controls forward so that they engage the shafts on the if. subchassis.

(4) Before tightening the couplers, set the BANDWIDTH control knob to 16 and the BFO PITCH control knob to 0, and then tighten the couplers.

(5) Reconnect plugs P112, P116, P213, and P218.

(6) Tighten the three green-headed captive screws.

62. Removal and Replacement of Vfo Subchassis (fig. 37)

a. General. Removal of this subchassis does not require the previous removal of any other subchassis. Handle this subchassis carefully to prevent its damage or misalignment.

Caution:
To prevent misaligning the vfo, avoid turning the vfo subchassis shaft or the KILOCYCLE CHANGE shaft on the rf gear train assembly. If the KILOCYCLE CHANGE shaft must be turned, record the setting and be sure to return it to the same setting before replacing the vfo. Do not disturb the Oldham coupler shaft clamps.

b. Removal.

(1) Remove the Oldham coupler antibacklash spring on the vfo subchassis drive shaft and place it in a tray for safekeeping.

(2) Turn the KILOCYCLE CHANGE control so that one slot in the Oldham coupler is vertical and the other is horizontal.

(3) Loosen the three green-headed captive screws (fig. 37) that secure the subchassis.

(4) Loosen, but do not remove, the two Phillips screws that secure the triangular bracket at the rear of the vfo subchassis. This is done to provide extra clearance for the removal of the subchassis.

(5) Disconnect plugs P109 (fig. 37) and P717 (fig. 36).

(6) Carefully remove the vfo subchassis from the main frame. The center disk of the Oldham coupler (fig. 70) will fall free. Place it in a tray with the antibacklash spring for safekeeping until the vfo subchassis is to be replaced.

c. Replacement. Replace the vfo subchassis as follows:

(1) Smear a little grease on the center disk of the Oldham coupler and press it in place against the first disk of the vfo drive shaft of the rf gear train tuning assembly.

(2) Lower the vfo subchassis into position in the main frame and engage the Oldham coupler; at the same time, engage, but do not tighten, the three green-headed captive screws. Replace the Oldham coupler antibacklash spring.

Note:
Remating the Oldham coupler will accurately reposition the vfo shaft.

(3) Tighten the two Phillips-head screws that secure the triangular-shaped bracket at the rear of the vfo subchassis.

(4) Tighten the three green-headed captive screws.

(5) Reconnect plugs P109 and P717.

(6) Check the frequency of the vfo (para 70*f*) if the shaft on the vfo has been turned from its original setting.

63. Removal and Replacement of Rf Subchassis Parts

a. Slug Racks and Tension Springs.

(1) *Removal*.

(*a*) Use paper clips or short pieces of solid wire fashioned into hooks to disengage the tension springs (fig. 36). Temporarily secure the tension springs to the gear and cam plates.

Caution:
Handle the slug racks carefully; the powdered iron cores are fragile.

(b) Lift each slug rack straight up out of the coils and tag it for identification.

(2) *Replacement*.

(a) Reinsert each slug into the same coils from which it was removed to prevent severe misalignment of the receiver.

(b) Reengage the tension springs to the holes at the ends of each slug rack.

(c) Remove the identification tags.

b. Bandswitch Shaft.

(1) *Removal.*

(a) Loosen but do not remove the rf band switch shaft coupler (fig. 56) at the front end of the band switch shaft (fig. 44).

(b) Slide the bandswitch shaft straight back through the hole in the rear of the rf subchassis. Be careful not to disturb the rotor settings of switch wafers S201 through S208 (fig. 44 and 45).

(2) *Replacement*.

Caution:
Be careful not to dam age the switch wafer rotors or disturb their settings.

(a) Slide the bandswitch shaft into the bandswitch as far as it will go.

(b) Tighten the bandswitch shaft coupler clamp.

c. Removal and Replacement Mechanically Tuned Coils and Transformers (fig. 43).

(1) *Removal*.

(a) Remove the slug rack and the tensions springs (*a* above).

(b) Remove the Phillips-head screw in the bottom of the slug hole.

(c) Pull the coil or transformer straight up from the rf subchassis.

(d) Remove the coil or transformer cover (if necessary) by pressing inward on the tabs on the sides of the cover and lifting the cover off.

(2) *Replacement*.

(a) Slide the cover down over the coil or transformer until the tabs snap into place.

(b) Plug the coil or transformer into the jacks on the rf subchassis.

(c) Replace the Phillips screw in the bottom of the slug hole.

(*d*) Replace the slug rack and the tension springs (*b* above).

64. Removal and Replacement of If. Subchassis Parts

a. If. Transformers (fig. 38). If. transformers T501, T502, and T503 are stagger tuned in some models. In other models, T501, T502, and T503 are tuned to 445 kc. Whenever any one of these transformers is replaced, perform the alignment procedures described in paragraph 72.

b. Mechanical Filters. To install a new mechanical filter, follow the procedures given in (1) through (10) below.

Note:
When replacing mechanical filters in the if. subchassis with MOD numbers 1 and above on Order No. 363-Phila-54 and in all receivers on Order No. 14-Phila-56, refer to the procedure in (10) below. Some receivers bearing Order No. 14-Phila-56 have alternate type filters (para 2*e*).

(1) After removing the defective filter, remove the small mica capacitors from the filter connection wires.

One of these capacitors (C507, C508, C509, or C510) is located beneath the chassis (fig. 40), the other (C513, C514, C515, or C516), above the chassis (fig. 38).

(2) Install the new filter and resolder the connecting wires to the proper terminals. *Do not reinstall the original mica capacitors across the filter terminals.*

(3) Connect the test equipment (fig. 57).

(4) Turn the BANDWIDTH control on the front panel to the position corresponding to the filter being replaced.

(5) Tune the AN/URM-25(*) and the receiver to the same frequency.

(6) The proper replacement value for C507, C508, C509, or C510, and C513, C514, C515, or C516, will be between 56 uuf and 130 uuf. Lightly solder .a random value capacitor within this range across the filter input terminals and another across the output terminals. Do not make a permanent connection.

(7) Apply power to the receiver and adjust the AN/URM-25(*) output level to produce 5 volts on the TS-505(*)/U. Record the AN/URM25(*) rf output level (microvolts).

(8) Try various capacitor values across the input and output terminals. Select the trial values (in uff) from the following list: 56, 62, 75, 82, 91, 100, 110, 120, and 130. Adjust and record the AN/URM25(*) output level for each trial value.

(9) The capacitor values that require the lowest AN/URM-25(*) output

level (highest gain) for a 5-volt reading of the TS-505(*)/U are the proper values for the replacement filter. Determine these values and solder the capacitors permanently in place. The proper value for the input capacitor is not necessarily identical with the value for the output capacitor. Both values must be determined independently. Replacement capacitors must be the silvered mica type.

(10) In if. subchassis with MOD numbers 1 and above on Order No. 363-Phila-54 and in all receivers on Order No. 14-Phila-56, variable trimmer capacitors are provided for tuning the mechanical filters FL502 through FL505 (fig. 39). Do not disconnect these capacitors. Connect the AN/URM-25(*) and the TS-505(*)/U (fig. 57) and adjust the trimmers for maximum gain. The trimmer associated with each filter is listed below.

Bandwidth (kc)	Mechanical filter	Input trimmer	Output trimmer
2.............	FL502	C567	C568
4.............	FL503	C566	C569
8.............	FL504	C565	C570
16.............	FL505	C564	C571

65. Removal and Replacement of Vfo Subchassis Parts

(fig. 49)

a. *Eternal Cover.*

(1) *Removal.*

(a) Remove the vfo subchassis (para 62*b*).

(b) Remove the two Phillips-head screws that secure the J709 mounting bracket.

(c) Remove the three Phillips-head screws and lockwashers spaced 120° around the front edge of the external cover.

(d) Remove the J709 cable clamp.

(e) Slide the external cover back slowly until it is disengaged from the heater winding cover.

(2) *Replacement.*

(a) Slide the external cover into place, and line up the three holes spaced 120°. Be sure that the two J709 mounting bracket holes are in a horizontal plane.

(b) Replace and secure the three Phillips-head screws and lockwashers.

(c) Replace and secure the J709 mounting bracket.

(d) Replace and secure the J709 cable clamp.

(e) Replace the vfo subchassis (para 62*c*).

b. Heater Winding Cover.

(1) Removal.

(a) Remove the external cover (*a*(1) above.

(b) Carefully remove the insulating sleeve from the heater winding cover.

(c) Remove the three Phillips-head screws spaced 120° around the front edge of the heater winding cover.

(d) Unsolder the two heater winding leads from the vfo subchassis terminals. Tag them for identification.

(e) (Slide the heater winding cover back slowly until it is disengaged from the sealed inner cover. Do not remove the sealed inner cover.

(f) Note the position of the compartment slot and the thermostat alignment pin before sliding the thermostat out of the heater winding cover.

(2) *Replacement.*

(a) Slide the thermostat into the new winding cover. Position the thermostat as in (1)(*f*) above.

(b) Slide the heater winding cover into place; line up the three holes spaced 120°; replace the three Phillips-head screws.

(c) Solder the S701 leads and the heater winding leads to the vfo subchassis terminals.

(d) Remove the identification tags.

(e) Carefully replace the insulating sleeve.

(f) Replace the external cover (*a*(*2*) above).

Section IV. ALIGNMENT AND ADJUSTMENT PROCEDURES

66. Test Equipment, Tools, and Materials Required for Alignment and Adjustment

a. Test Equipment. The following test equipment, tools, and materials are required for alignment and adjustment of the receiver.

Nomenclature
Rf Signal Generator Set AN/URM-25(*) with Electronic Equipment Kit MK-288/URM.
Electronic Multimeter TS-505(*)/U.
Multimeter TS-352(*)/U.
Voltmeter, Meter ME-30(*)/U.

b. Tools.

(1) Bristo wrench (mounted on receiver rear panel).

(2) Phillips-head screwdriver (mounted on receiver rear panel).

(3) Tool Kit TK-87/U. Use Tool Equipment TE-113 if Tool Kit TK-87/U is not available.

c. Materials.

(1) Carbon resistor, 600-ohm 1-watt.

(2) Carbon resistor, 50-ohm 1-watt.

67. General Alignment Information

Use the fluted Bristo wrench, mounted on the rear panel of the receiver, for' adjusting the antenna, the rf, and the variable if. cores. Use the same tool for adjusting the tuning shafts during mechanical synchronization. Use a nonmetallic screwdriver for adjusting the various trimmer capacitors. Use a hexagonal, nonmetallic tool for adjusting the cores in T501, T502. T503, and Z503 on the if. Sub-chassis. Be sure that this tool is inserted through the top core into the bottom core, and that the bottom core turns without disturbing the setting of the top core. Make this type of adjustment only after the particular coil or transformer has been replaced.

68. Test Conditions

Unless specified otherwise, conduct all alignment and test procedures under the following conditions.

a. Temperature: Nor m al room or shelter.

b. Humidity: Normal room or shelter.

c. Line Voltage and Frequency: 115 or 230 volts ac ±1 percent at 60 cps.

d. Warmup Period: At least 15 minutes.

e. Standard Modulation: 30 percent am at 400 cps.

f. Screened Room: Mandatory in electrically noisy areas.

69. Preparation for Alignment

Before applying power to the receiver, the following conditions must exist:

a. All the controls must operate freely and the knobs must be securely attached to their shafts.

b. The tubes and tube shields must be securely in place.

c. All connectors must be seated firmly.

d. The jumpers must be connected between terminals 1 and 2, 3 and 4, 11 and 12, and 14 and 15 on the rear panel of the receiver.

e. The KILOCYCLE CHANGE dial over-travel must not be less than 25 kc at each end.

f. The receiver must be grounded, and ac power must be applied; the front-panel controls (para 36) must be set.

g. The B+ voltage between chassis ground and the +150 V test point E607 (fig. 51) should be between - +148 volts and +153 volts.

h. All tube filaments must be lighted.

i. The antenna relay must be actuated when the FUNCTION switch is placed in the STAND BY and CAL positions.

j. The FUNCTION switch must be set to AGC and the RF GAIN control turned fully counterclockwise. CARR-METER ADJ control R523 (fig. 38) on the if. subchassis must be adjusted for a CARRIER LEVEL meter indication of 0.

70. Mechanical and Electrical Synchronization
(fig. 67 through 70)

The receiver tuning elements, which consist of the frequency indicator, KILOCYCLE CHANGE, and MEGACYCLE CHANGE 10-turn stops, the 6-position rf band switch, the second crystal band switch, and the vfo, must be in synchronization with the rf gear train before electrical alignment is attempted. If the receiver is being realigned because of low sensitivity or replacement of parts such as the variable if., the fixed if., or the rf transformers, it should not be necessary to check the mechanical and electrical synchronization. Nonsynchronization of the tuning shafts and the rf gear train is likely to occur as a result of the removal and replacement of the rf subchassis, crystal-oscillator subchassis, vfo subchassis, or the disassembly of part or all of the rf gear train assembly. Check and adjust the following items as may be necessary.

a. Ten-Turn Stops. Check the 10-turn stops (fig. 69) by rotating the MEGACYCLE CHANGE and KILOCYCLE CHANGE shafts fully counterclockwise. The first two digits on the frequency indicator should indicate halfway between 99 and 00 me (off the detent position). The next three digits should indicate between -963 and -972 kc.

b. Slug-Rack Cams and Followers (fig. 36). Check the slug-rack cam followers at the high and low ends of each coil range. Normally, all cam followers should be near (but not at) the peak of the cams at the high end of the coil ranges.

Note:
If the cam followers do not function as described below, fifth echelon repair is required.

(1) All cam followers, except the cams for the 0.5- to 1-mc range, should not quite reach the peak of the cams at the high end of the range.

(2) The cam followers for the 0.5- to 1-mc range may pass over the peak of the cams for a KILOCYCLE CHANGE control reading of +025 or higher.

(3) All cam followers except the 0.5to 1-mc cam followers should not quite reach the valley of the cams as the KILOCYCLE CHANGE control is turned to the low end of the coil ranges.

(4) The 0.5- to 1-mc cam followers may pass through the valley and start up the other side of the cams as the KILOCYCLE CHANGE control is adjusted to a reading of about 475.

(5) The cam follower on first variable if. Z213 (17.5 to 25 mc) is near the valley of the cam when the KILOCYCLE CHANGE control reading is 500, and rises to near the peak at 07 +000.

(6) The cam follower on second variable if. Z216 (3 to 2 mc) is near the valley of the cam when the KILOCYCLE CHANGE control is rotated fully clockwise, and near the peak when the KILOCYCLE CHANGE control is fully counterclockwise.

c. Camshafts.

Note:
If any cams have been synchronized with the rf subchassis removed from the main frame, the vfo subchassis must be synchronized (*f* below) after the rf subchassis is replaced.

(1) Set the MEGACYCLE CHANGE and KILOCYCLE CHANGE controls for a frequency-indicator reading of 07 +000. The camshafts are synchronized if the cam positioning marks on the pressed cam plates line up with the points of the cams and the intermittent switch drive gears are as shown in figure 68.

(2) If all the cams line up at some other frequency indications, perform the following:

(a) Position the MEGACYCLE CHANGE and KILOCYCLE CHANGE controls until the cam points are lined up with the cam positioning marks.

(b) Loosen the two bevel gear clamps on the mechanical counter (fig. 67).

(c) Manually adjust the counter dial to 07 +000.

(d) Tighten the gear clamps.

(3) If one cam does not line up with the cam position mark, perform the following:

(a) Loosen the clamp on the front end of the individual camshaft.

(b) Line up the cam point with the cam positioning mark.

(c) Tighten the clamp.

Note:

To avoid losing the nut, do not loosen the clamp more than necessary. Be careful not to strip the screw thread when tightening.

d. Six-Position Rf Band Switch (fig. 44).

(1) Position the MEGACYCLE CHANGE and KILOCYCLE CHANGE controls for a frequency indicator reading of 07 +000.

(2) Remove V207.

(3) Disconnect P108 (fig. 36) from J208.

(4) Connect the TS-352(*)/U between pin 6 of XV207 and pin D of J208. The indication should be approximately 56,000 ohms.

(5) Turn the MEGACYCLE CHANGE control to 08. The TS-352(*)/U should indicate an infinite reading.

(6) If the indications are *not* as in (4) and (5) above, continue with procedures (7), (8), and (9).

(7) Disconnect the TS-352(*)/U and reinsert V207.

(8) Remove the front panel (para 58) and the rf subchassis (para 59).

(9) Loosen the rf band switch clamp (fig. 69). Turn the band switch shaft until the rotors are centered on the contacts which provide the indications required in procedures (4) and (5) above. Tighten the rf band switch clamp.

e. Crystal-Oscillator Subchassis Band Switch.

(1) The crystal-oscillator band switch is synchronized when the indicator wheel number (fig. 36) that appears in the hole on the crystal-oscillator subchassis agrees with the first two digits of the frequency indicator.

Note:

Only even numbers appear on the indicator wheel; odd numbers appear as straight lines between numbers; 00 on the frequency indicator appears as 0.

(2) If the indication is incorrect, set the receiver controls as directed in paragraph 36 and turn the FUNCTION switch to STAND BY.

(3) Connect the TS-505(*)/U between test point E210 (fig. 43) and chassis ground.

(4) Loosen the shaft coupler. Insert a long screwdriver through the SYNC XTAL OSC hole in the rear panel of the receiver and turn the crystal-oscillator band switch shaft to the correct number.

(5) Tighten the shaft coupler.

(6) Turn the MEGACYCLE CHANGE control to each side of the detent point. The TS-505(*)/U indication should be -3.5 to -8 volts at the detent point and should drop to zero each side of the detent point. If not, readjust the crystal-oscillator band switch shaft ((4) and (5) above) to meet this condition.

(7) Disconnect the TS-505(*)/U.

f. Vfo Tuning Shaft.

(1) Preset the receiver (para 36). Turn the FUNCTION switch to MGC. Allow 15 minutes for warmup.

(2) Tune the receiver to station WWV or a local station of known frequency. Be sure to set the frequency indicator exactly to the station's assigned frequency.

(3) Turn the BANDWIDTH switch to .1.

(4) Remove the antibacklash spring on the Oldham coupler (fig. 70) and loosen the vfo (fig. 37) shaft clamp nearest the front panel.

Caution:

The vfo will be permanently damaged if the shaft is turned TOO FAR IN EITHER direction. The end of shaft travel can be felt while turning the shaft with the fingers. Do not force the shaft.

(5) Turn the shaft until the station is tuned for maximum loudness.

(6) Tighten the shaft coupler and replace the antibacklash spring.

(7) With the first two digits of the frequency indicator set at- any position except 00, check the receiver calibration at the low, middle, and high frequency end of the band.

71. Adjusting ZERO ADJ Control

Check the adjustment of the ZERO ADJ control as follows:

a. Turn the ZERO ADJ knob fully counterclockwise. Slowly turn the knob clockwise and observe the free play in the knob.

The free play should be approximately 1/8 turn.

b. If there is no free play, or if the free play is excessive, remove the knob.

c. With the thumb and forefinger, adjust the shaft for approximately 1/8-turn free play.

d. Replace the knob so that the stop on the rear of the knob is directly to the right -of, and touching the finger on, the ZERO ADJ control locking washer on the front panel. Tighten the knob.

e. Turn the ZERO ADJ control fully clockwise to the stop, and check to see that the locked clutch gear assembly (fig. 67) is disengaged. Do this by rocking the KILOCYCLE CHANGE control back and forth and observing the reading of the frequency indicator to see that it does not change.

f. Turn the ZERO ADJ control fully counterclockwise to the stop and recheck for approximately 1/8-turn free play.

g. Repeat the procedures in *b* through *f* above if the free play and clutch disengagement are not as specified.

72. Alignment of Fixed-Tuned If. Circuits
(fig. 36 and 38)

If. transformers T501, T502, and T503 are stagger-tuned in some models and all are tuned to 455 kc in other models. If. transformer T208 (fig. 43) and tuned circuit Z503 are tuned to 455 kc on all models. Normally, none of these components

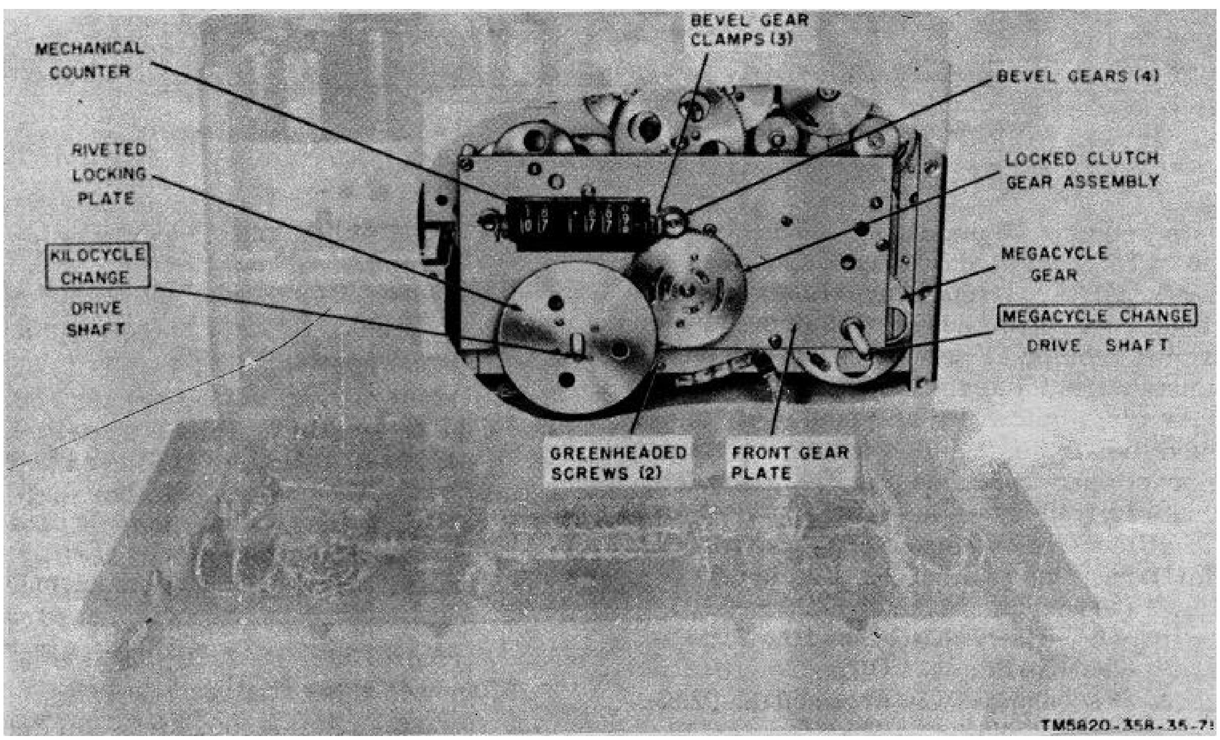


Figure 67. Rf gear train assembly, location of parts.

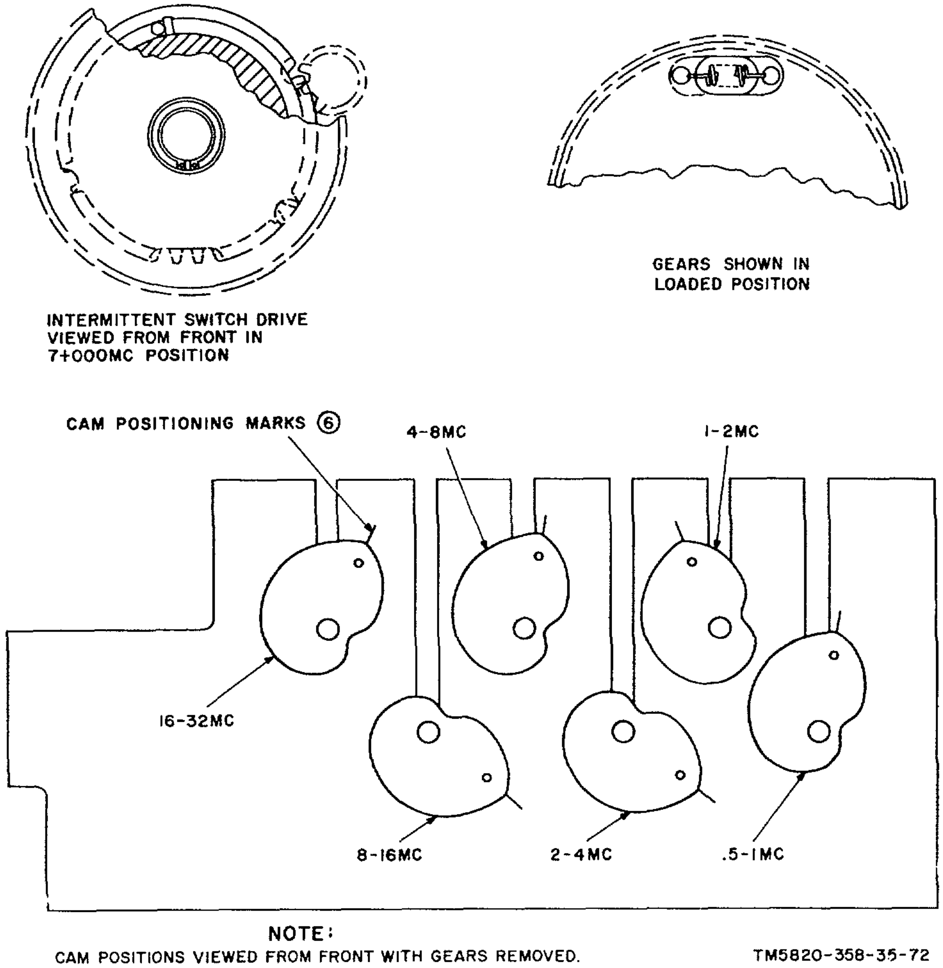


Figure 68. Mechanical alignment details.

require alignment. However, when T501, T502, or T503 is replaced in any model, all three transformers should be aligned as directed in the procedures given in *a* below. Transformer T208 can be adjusted from the top of the transformer cover, but T501, T502, T503, and Z503 cannot be adjusted unless their covers are removed and modified covers installed temporarily.

a. Alignment of T501, T502, and T503.

(1) Set the controls as indicated in paragraph 36. Turn the BANDWIDTH switch to 16, and the FUNCTION switch to MGC.

(2) Disconnect P114 from J514, P213 from J513, and P218 from J518. Connect P114 to J513.

(3) Connect the output of the AN/URM25(*) to the IF OUTPUT jack on the receiver rear panel, (4) Remove the cover from T501, T502, or T503, whichever is to be replaced, by removing the top nuts and lockwashers. Punch or drill a hole in the top of the removed cover. The hole must be large enough to pass the alignment tool and must be centered over the transformer core when installed.

(5) Install the replacement transformer T501, T502, or T503 complete with the modified cover.

(6) Locate resistor R504 (fig. 40). If the resistor has a value of 1,000

ohms, replace it with a 500-ohm resistor of the same wattage.

(7) Connect the TS-505(*)/U between DIODE LOAD terminal 14 and chassis ground, with the negative lead at terminal 14.

(8) Remove the cover from transformer T501 and replace it with the modified cover ((4) above). Tune the AN/URM-25(*) to 467 kc and adjust its output for a diode load voltage between -3 and -7 volts.

(9) Adjust the secondary (top) slug of T501 for maximum diode load voltage. Reduce the signal generator output, as necessary, to keep the diode load voltage between -3 and -7 volts.

(10) Remove the modified cover from T501 and replace it with the permanent cover.

(11) Follow the procedures given in (8), (9), and (10) above and adjust the primaries and secondaries of T502 and T503, and the primary of T501, in the order listed below:

Step	Modified cover on	AN/URM-25(*) frequency (kc)	Adjust
1	T501 and T502	467	T501 secondary (top slug). T502 primary (bottom slug).
2	T501 and T502	443	T501 primary (bottom slug).
3	T503	455	T503 primary (bottom slug). T503 secondary (top slug).

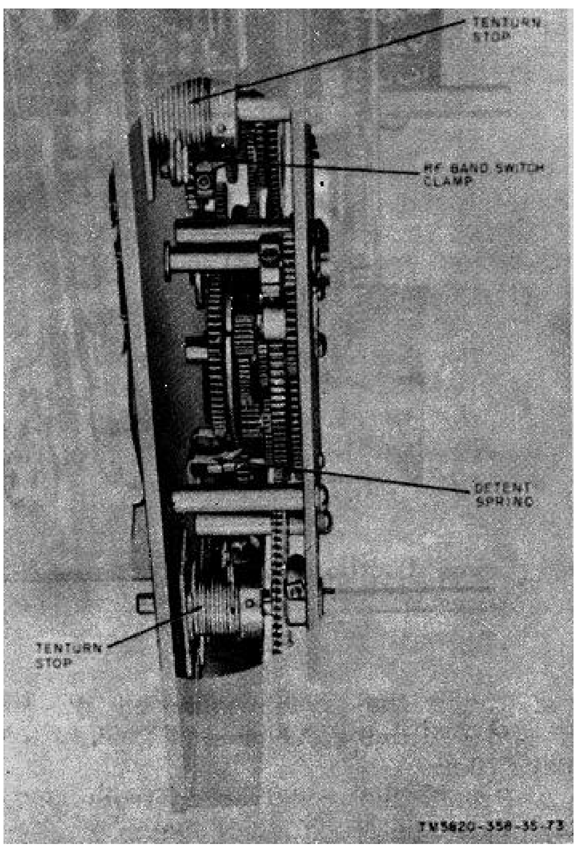


Figure 69. Location of rf band switch shaft clamp, detent spring, and ten-turn stops.

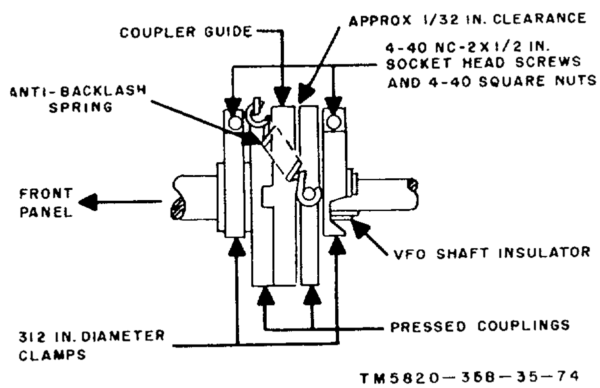


Figure 70. Oldham coupler details.

(12) When the alignment is complete and the permanent covers are on all three transformers, disconnect the test equipment and reconnect P114 to J514, P113 to J513, and P218 to J518.

b. Alignment of Z503.

(1) Perform the procedures given in a(1) through (3) above.

(2) Turn the FUNCTION switch to AGC.

(3) Replace Z503 if it is defective. Remove the cover from the old Z503, and punch or drill a hole in the top of it. Replace the cover on the new coil.

(4) Connect the TS-505(*)/U to AGC terminal 4 and chassis ground on the rear panel of the receiver.

(5) Tune the AN/URM-25(*) to 455 kc, and adjust the attenuator on the AN/URM-25(*) for an agc voltage indication of -1 to -2 volts on the TS-505(*)/U.

(6) Adjust the single core in Z503 for maximum agc voltage; then remove the cover ((3) above) and replace it with the new cover.

c. Alignment of T208 (fig. 43).

(1) Set the receiver controls as instructed in a (1) above. Turn the BANDWIDTH switch to 2.

(2) Connect the output of the AN/URM25(*) to test point E211 (fig. 43). Connect the TS-505(*)/U between DIODE LOAD terminal 14 and chassis ground.

(3) Tune the AN/URM-25(*) to 455 kc and adjust the AN/URM-25(*) attenuator for aTS-505(*)/U reading of between -3 and -7 volts.

(4) Adjust T208 for maximum indication on the TS-505(*)/U. The adjustment of T208 will be broad.

(5) Disconnect the test equipment.

73. Adjustment of GAIN ADJ Potentiometer R519
(fig. 36 and 38)

a. General. The correct adjustment of this control is very important. If it is set too low, the receiver sensitivity will be below that required; if it is set too high, the receiver' noise will be excessive. This adjustment should be checked monthly and whenever any tubes are replaced in the rf or if. subchassis. When two receivers are operated in diversity operation, the if. outputs should be balanced with GAIN ADJ R519. This is done by setting the gain of one receiver, and then matching the gain of the other receiver to it.

b. Procedure for Adjustment.

(1) Disconnect P114 from J514, P213 from J513, and P218 from J518. Connect P114 to J513.

(2) Connect the AN/URM-25(*) through Adapter, Test MX-1487/URM-25D or Impedance Matching Network CU-206/URM-25F to the IF OUTPUT jack on the rear panel of the receiver.

(3) Tune the AN/URM-25(*) to 455 kc and adjust the AN/URM-25(*) attenuator for an output level of 150 microvolts. Be sure that the modulation is turned off.

(4) Connect the TS-505(*)/U between DIODE LOAD terminal 14 and chassis ground.

(5) Set the receiver controls as instructed in paragraph 36. Turn the FUNCTION switch to MGC.

(6) Loosen the hexagonal nut on the GAIN ADJ control and adjust the control for a diode load voltage reading of -7 volts. Tighten the hexagonal nut.

(7) Disconnect the test equipment. Reconnect P213 to J513, P218 to J518, and P114 to J514.

c. Adjustment for Diversity Operation.
When the signals at the IF OUTPUT jacks of the two receivers are used for diversity operation, proceed as follows:

(1) Check CR101 (para 53*a*).

(2) Adjust one receiver according to the instructions given in *b* above.

(3) Perform the procedures in *b* above for the second receiver. *Do not change* the settings of the AN/ URM-25(*) in any way.

74. Crystal-Oscillator Subchassis Trimmer Alignment
(fig. 71)

a. Check the synchronization of the crystal-oscillator subchassis band switch (para 70*e*).

b. Preset the receiver controls (para 36). Turn the FUNCTION switch to CAL.

c. Turn the MEGACYCLE CHANGE control to 08 and adjust the corresponding trimmer for a maximum CARRIER LEVEL meter indication.

Note:
Trimmers No. 8 and 9 correspond to frequency-indicators No. 08, and 09. There are no adjustments for bands 00 through 07, Check only for output on these bands.

d. Turn the MEGACYCLE CHANGE control to each band from 08 through 31 and adjust the corresponding trimmer for a maximum CARRIER LEVEL meter indication.

75. Second Variable If. Alignment
(fig. 72)

Remove the top protective cover, located over the alignment points, from the rf subchassis, a copy of figure 72 is located on this cover. Use this illustration to locate alignment points.

a. Preparation.

(1) Preset the receiver controls (para 36). Turn the frequency indicator to 01 900.

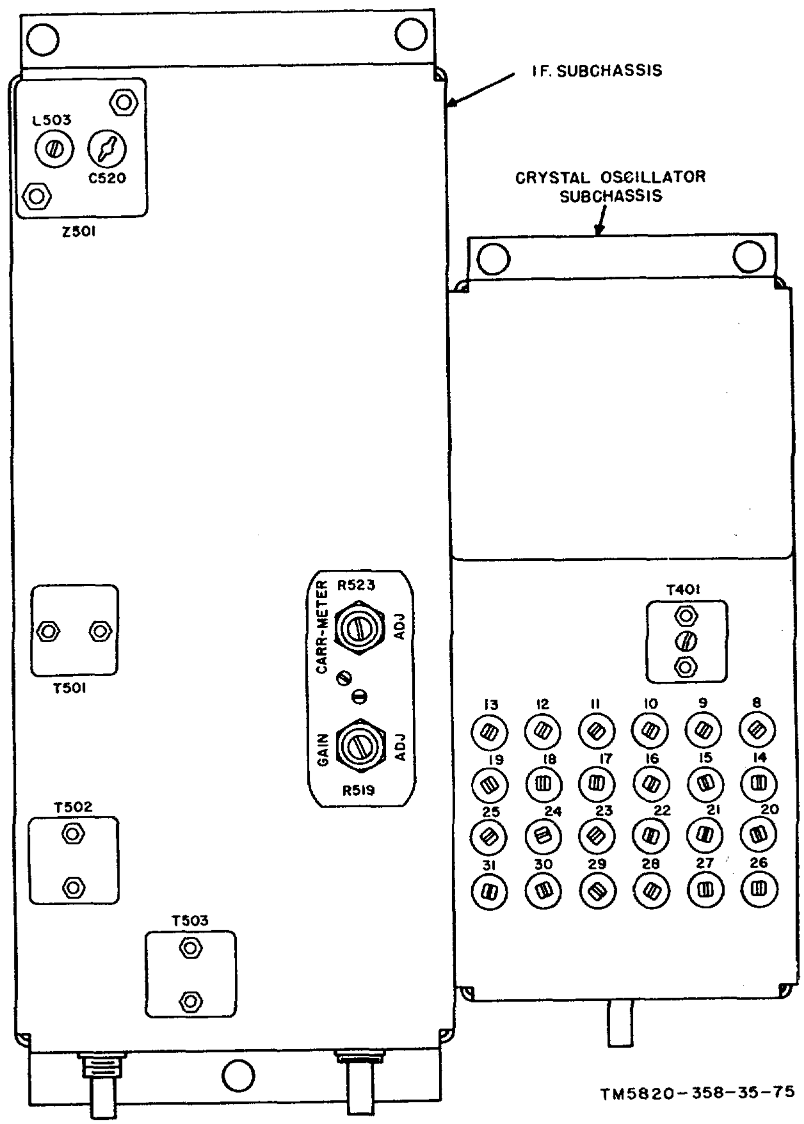


Figure 71. Crystal-oscillator and if. subchassis alignment points.

(2) Calibrate the receiver (TM 115820-358-10).

(3) Turn the FUNCTION switch to MGC.

(4) Refer to figure 57, and connect the TS-505(*)/U as illustrated. Use Test Lead CX-2919/U (part of AN/ URM-25(*) instead of Cord W104 and connect the AN/URM-25(*) to test point E210 (fig. 43).

b. Alignment.

Note:

In procedures 2 and 5 below, set the AN/URM-25(*) to the specified frequency. Slowly rock the AN/URM-25(*) tuning dial and set it for zero beat with the receiver (BFO switch on and BFO PITCH control at 0). Do not rely on the AN/URM-25(*)tuning dial indication. During alignment readjust the AN/URM-25(*) output level as necessary to keep the TS-505(*)/U indication between -3 and -5 volts.

(1) Set the receiver frequency-indicator at 01 900.

(2) Tune the AN/URM-25(*) to 2.1 mc.

(3) Adjust the slugs in Z216-1, Z216-2, and Z216-3 (L233-1 through L233-3) for a maximum TS-505(*)/U indication.

(4) Set the receiver frequency-indicator at 01 100.

(5) Tune the AN/URM-25(*) to 2.9 mc.

(6) Adjust the trimmer capacitors in Z216-1, Z216-2, and Z216-3 (C291-1 through C291-3) for a maximum TS-505(*)/U indication.

(7) Repeat the procedures given in (1) through (6) above until no further increase in TS-505(*)/U indication is obtainable.

76. First Variable If. Alignment

(fig. 72)

a. Preparation.

(1) Preset the receiver controls (para 36).

(2) Set the frequency indicator at 01 200.

(3) Calibrate the receiver (TM 115820-358-10).

(4) Turn the FUNCTION switch to MGC.

(5) Refer to figure 57 to connect the TS-505(*)/U as illustrated. Connect the AN/URM-25(*) to test point E209 (fig. 43). Use Test Lead CX2919/U (part of AN/URM-25(*)) instead of W104.

b. Alignment.

Note:

In procedures 2 and 7 below, set the AN/URM-25(*) to the specified frequency. Slowly rock the AN/URIM-25(*) tuning dial and set it for zero beat with the receiver (BFO switch at ON and BFO PITCH control at 0). Do not rely on the AN/URM-25(*) tuning dial indication. During alignment, readjust the AN/URNI-25(*) output level as necessary to keep the TS-505(*)/U indication between -3 and -5 volts.

(1) Set the receiver frequency indicator to 01 250.

(2) Tune the AN/URM-25(*) to 18.75 mc.

(3) Adjust the slugs in Z213-1, Z213-2, and Z213-3 (L232-1 through L232-3) for a maximum TS-505(*)/U indication.

(4) Set the receiver frequency indicator to 07 200.

(5) Recalibrate the receiver.

(6) Set the receiver frequency indicator to 07 250.

(7) Tune the AN/URM-25(*) to 24.25 mc.

(8) Adjust the trimmer capacitors in Z213-1, Z213-2, and Z213-3 (C283-1 through C283-3) for a maximum TS-505(*)/U indication.

(9) Repeat the procedures given in (1) through (8) above until no further increase in TS-505(*)/U indication is obtainable.

77. Rf Coil Alignment

a. Preparation.

(1) Preset the receiver controls (para 36).

(2) Turn the ANT TRIM control to 0 and the FUNCTION switch to MGC.

(3) Connect the test equipment as illustrated in figure 57.

b. Procedure. In each step in the rf coil alignment chart (*c* below), first perform procedures (1) through (5) below.

(1) Set the receiver and the AN/URM25(*) to the frequency listed.

(2) Turn the BFO switch to ON.

(3) Turn the BFO PITCH control to 0.

(4) Slowly rock the AN/URM-25(*) tuning dial and set it for zero beat

with the receiver. Do not depend on the AN/URM-25(*) tuning dial indication.

(5) Adjust the slugs or trimmer capacitors for maximum TS-505(*)/U indications.

Note:
Adjust the AN/URM-25(*) rf output level, as necessary, to keep the TS505(*)/U indication between -3 and -7 volts.

c. *Alignment Chart* (fig. 91).

Receiver (mc)	Receiver (kc)	AN/URM-25(*) freq (kc)	Adjust slugs for peak	Adjust trimmer capacitors for peak
00	550	550	L213 L224-1 L224-2	
00	950	950		C201-B C230-1 C230-2
01	100	1,100	L215 L225-1 L225-2	
01	900	1,900		C205B C233-1 C233-2
02	200	2,200	L217 L226-1 L226-2	
03	800	3,800		C209B C236-1 C236-2
04	400	4,400	L219 L227-1 L221-2	
07	fi00	7,600		C213B C239-1 C239-2
08	800	8,800	L221 L228-1 L228-2	
15	200	15,200		C217B C242-1 C242-2
17	600	17,600	L223 L229-1 L229-2	
30	400	30,400		C221B C241-1 C245-2

78. Beat-Frequency Oscillator Neutralization

a. Preset the receiver controls (para 36). Set the BANDWIDTH switch to .1 and the FUNCTION switch to CAL.

b. Tune the receiver for a maximum CARRIER LEVEL meter indication at any 100-kc calibration point.

c. Turn the BFO switch to ON and turn the BFO PITCH control to 1.

d. Set the FUNCTION switch to AGC and the BANDWIDTH switch to 2.

e. Connect the ME-30(*)/U, in parallel with a 50-ohm, noninductive resistor, to IF OUTPUT jack J116 on the receiver rear panel.

f. Disconnect P213 (fig. 36) from J513, and short J513 to chassis ground.

g. Insert an insulated screwdriver

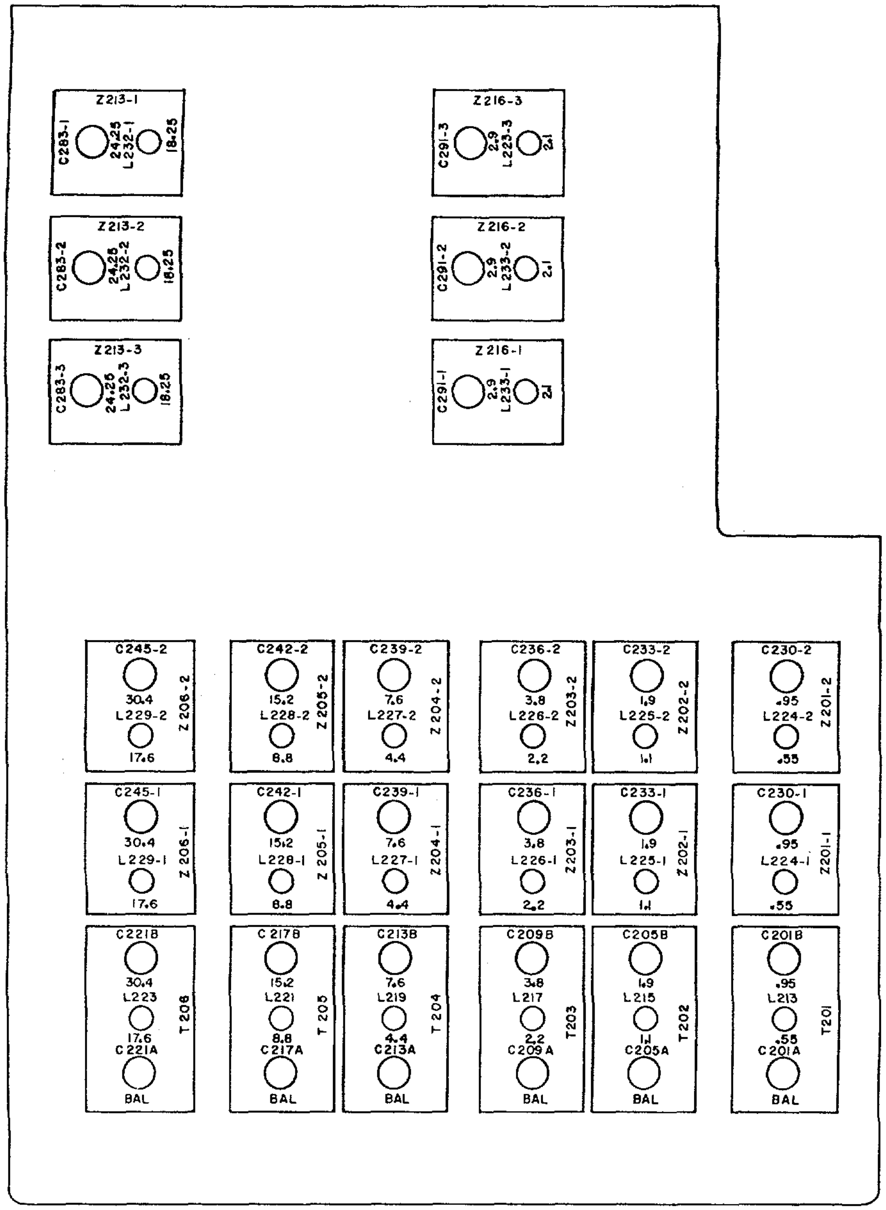


Figure 72. Rf and variable if. alignment points.

through the receiver left end plate access hole and adjust bfo neutralization capacitor C525 (fig. 42) for a minimum ME30(*)/U indication.

79. Calibration Oscillator Adjustment

This adjustment requires the use of an extremely accurate frequency standard for 118 determining the reference frequency. The Bureau of Standards Station WWV at Washington, D. C. should be used as the frequency standard if it is possible to receive signals from this station. Station WWV operates on frequencies of 2.5 mc, 5 mc, 10 mc, 15 mc, and 20 mc. Use the highest frequency signal that can be reliably received by the receiver.

a. Tune in the highest frequency signal from WWV that can be reliably received.

b. Turn the BANDWIDTH switch to .1.

c. Tune the receiver to the exact resonance by adjusting the KILOCYCLE CHANGE and ANT TRIM controls for a maximum CARRIER LEVEL meter indication.

d. Turn the LINE GAIN control to approximately 5, turn the LINE METER switch to -10 and adjust the LINE GAIN control for a half-scale LINE LEVEL meter indication.

e. Turn the BFO switch to ON and adjust the BFO PITCH control to the exact zero beat with WWV. This will be when the LINE LEVEL meter indication drops to zero and fluctuates at a slow rate.

f. Turn the FUNCTION switch to CAL.

g. Use a screwdriver to adjust the CAL ADJ capacitor C310 (fig. 45) through the rear-panel access hole for exact zero beat (a MINIMUM LINE LEVEL meter indication).

h. Turn the FUNCTION switch to AGC, and tune to station WWV at the other frequencies to check the accuracy of. the calibration oscillator adjustment.

80. CARR-METER ADJ Potentiometer R-523 Adjustment

(fig. 38)

a. Set the FUNCTION switch to AGC and turn the RF GAIN control fully counterclockwise.

b. Adjust the CARR-METER ADJ potentiometer on the if. subchassis for a zero reading of the CARRIER LEVEL meter on the receiver front panel.

81. Variable-Frequency Oscillator End-Point Adjustment

(fig. 73)

After the receiver has been in service for about a year, a frequency check of the variable-frequency oscillator may reveal that its range may not be exactly 3.455 to 2.455 mc. In most cases, this condition is caused by aging of the frequency-determining components in the sealed vfo subchassis, and can be compensated for by the adjustment of end-point adjustment L701. Access to this adjustment is made by the removal of the screw on the front of the sealed vfo unit.

Note:

Make this adjustment if the inaccuracy of the vfo exceeds 500 cps when checked from 000 to +000 on the last three digits of the frequency indicator. the end-point adjustment as follows:

a. Remove the vfo subchassis (para 62*b*).

b. Remove the end-point-adjustment cover nut.

c. Replace the vfo subchassis (para 62*c*).

d. Preset the receiver controls (para 36) and allow the receiver to warm up for at least 1 hour.

Note:

Set the OVENS switch on the receiver rear panel to the same position to which the user will set it.

e. Calibrate the receiver (TM 11-5820-358-10) at exactly 07 +000.

f. Remove the front panel (para 58).

g. Turn the riveted locking plate (fig. 67) by hand for a frequency-indicator setting of 07 +000.

h. Use a thin screwdriver through the vfo end-point-adjustment access hole (fig. 73) to adjust L701 for zero beat.

i. Turn the riveted locking plate by hand for a setting of exactly 07 +000.

j. Turn the shaft of the BFO PITCH control for zero beat.

k. Repeat the procedures given in *g* through *j* above until no further improvement can be made.

l. When the job has been completed, remove the vfo, replace the end-point-adjustment nut, replace the vfo, d replace the front panel (para 58*c*).

82. Crystal Filter Neutralizing

(fig. 71)

Capacitor C520 in tuned circuit Z501 usually needs adjustment only when part or all of Z501 is replaced or when C520 is turned accidentally. Proceed as follows:

a. Preset the receiver controls (para 36). Set the BANDWIDTH switch to .1 and the FUNCTION switch to MGC.

b. Refer to figure 57 and connect the TS-505(*)/U as shown. Connect the AN/ URM-25(*) to test point E211 (fig. 43).

Use Test Lead CX-2919/U (part of AN/URM-25(*) instead of W104.

c. Tune the AN/URM-25(*) to 455 kc and adjust its rf output level for a TS505(*)/U indication of -5 volts.

d. Rock the AN/URM-25(*) tuning dial for a maximum TS-505(*)/U indication; then readjust the rf output level for a -7 volt TS-505(*)/U indication.

e. Record the AN/URM-25(*) rf output level, and then increase it by 60 db (1,000 times the previous level).

f. Increase the AN/URM-25(*) frequency until the TS-505(*)/U again indicates -7 volts.

g. Adjust the C520 for a dip in the TS505(*)/U indication, and mark the C520 setting on the Z501 shield cam.

h. Decrease the AN/URM-25(*) frequency below 455 kc until the TS-505(*)/U indication is again -7 volts.

i. Readjust C520 for a dip in the TS505(*)/U indication and mark this second C520 setting on the Z501 sheild can.

j. Set the C520 halfway between the marks made in procedures *g* and *i* above.

k. Retune the AN/URM-25(*) for a maximum TS-505(*)/U indication at 455 kc; then readjust the rf output level for a -7volt TS-505(*)/U indication. Record the AN/URM-25(*) frequency setting.

l. Turn the BANDWIDTH switch to 1.

m. Retune the AN/URM-25(*) for a maximum TS-505(*)/U indication. Compare the peak frequency with the one recorded in procedure *k* above.

n. If the peak frequency is different, adjust L503 in Z501 until the peak frequency is the same for both the .1 and 1-kc positions of the BANDWIDTH switch.

Note:
This may require several readjustments of L503.

83. Antenna Trimmer Control Adjustment

a. The ANT TRIM control is properly adjusted if the gear with the red dot is

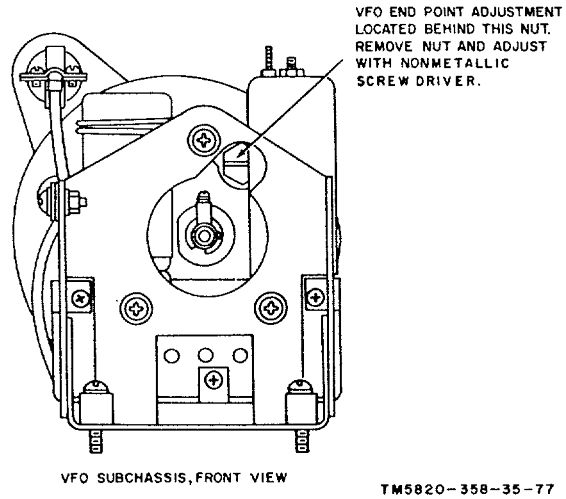


Figure 73. Variable-frequency oscillator end-point adjustment.

positioned as shown in figure 74 when the ANT TRIM control is set at 0.

b. If adjustment is necessary, proceed as follows:

(1) Loosen the drive gear setscrews.

(2) Turn the gear with the red dot to the position shown in figure 74.

(3) Turn the ANT TRIM knob to 0 while holding the drive gear to prevent the gear with the red dot from turning.

(4) Tighten the drive gear setscrews.

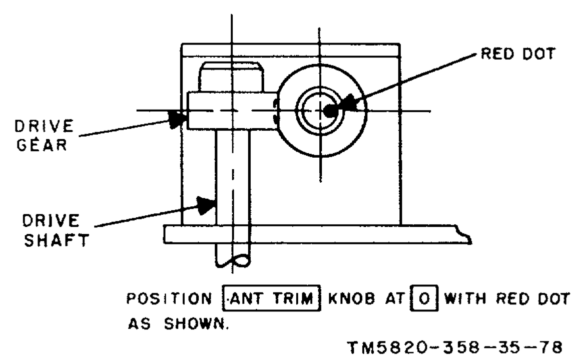


Figure 74. ANT TRIM control adjustment.

CHAPTER 3

FOURTH ECHELON TROUBLESHOOTING AND TESTING PROCEDURES

Section I. FOURTH ECHELON TROUBLESHOOTING

84. Troubleshooting Line Audio Channel for Distortion

a. Check the line and local audio channels for distortion (para 96). If the line audio channel fails to pass the test but the local audio channel passes, check the circuit components of V602B and V604.

b. If both the line and local audio channels fail to pass the test, check the circuit components of V601A, V601B, V507.

85. Troubleshooting Local Audio Channel for Distortion

a. Check the local and line audio channels for distortion (para 96). If the local audio channel fails to pass the test but the line audio channel passes, check the circuit components of V602A and V603.

b. If both channels fail to pass the test, check the circuit components of V601A, V601B, and V507.

Section II. FOURTH ECHELON TESTING PROCEDURES

86. General

a. These testing procedures are prepared for use by Signal Field Maintenance Shops and Signal Service Organizations responsible for fourth echelon maintenance to determine the acceptability of repaired signal equipment. These procedures set forth specific requirements that repaired signal equipment must meet before it is returned to the using organization. The testing procedures may also be used as a guide for testing equipment repaired at third echelon if the proper tools and test equipment are available. A summary of the performance standards is given in paragraph 98.

b. Each test depends on the preceding one for certain operating procedures and, where applicable, for test equipment calibrations. Comply with the instructions preceding the body of each chart before proceeding to the chart. Perform each test in sequence. Do not vary the sequence. For each step, perform all the actions required in the *Test equipment control settings* columns; then perform each specific test procedure and verify it against its performance standard.

87. Test Equipment and Other Equipment Required

All test equipment and other equipment required to perform the testing procedures given in this section are listed in the following charts and are authorized under TA 11-17 (Signal Field Maintenance Shops) and TA 11-100 (11-17) (Allowances of Signal Corps Expendable Supplies for Signal Field Maintenance Shop, Continental United States) or are repair part items of the subject equipment authorized for stockage at fourth echelon levels.

a. *Test Equipment*

Nomenclature	Federal stock No.	Technical manual
Output Meter TS-585(*)/U[a]	6625-244-0501	TM 11-5017
Audio Oscillator TS-382(*)/U[b]	6625-192-5094	TM 11-2684A
Spectrum Analyzer TS-723A/U	6625-668-9418	TM 11-5097
Electric Light Assembly /PAQ	6695-537-4470	TM 11-5540

Nomenclature	Federal stock No.	Technical manual
Oscilloscope OS-8(*)/U[c]	6625-568-4898	TM 11-1214 TM 11-1214A
R. F. Signal Generator Set AN/URM-25(*)[d]	6625-309-5381 or 6625-570-5719	TM 11-5551D or TM 11-5551F
Electronic Multimeter TS-505(*)/U[e]	6625-243-0562	TM 11-5511 TM 11-6625-239-12
Voltmeter, Meter ME-30(*)/U[f]	6625-669-0742	TM 11-6625-320-12

[a] Indicates TS-585A/U, TS-585B/U, TS-585C/U, and TS-585D/U.
[b] Indicates TS-382A/U, TS-382B/U, TS-382D/U, and TS-382E/U.
[c] Indicates OS-8A/U, and OS-8C/U.
[d] Indicates AN/URM-25D and AN/URM-25F.
[e] Indicates TS-505/U and TS-505A/U through TS-505D/U.
[f] Indicates ME-30A/U and ME-30B/U.

b. Other Equipment.

Nomenclature	Federal stock No.
Hleadset HS-30-U	5965-164-7259
Telephone Plug PL-055-B (or equivalert).	5935-192-4760
Electronic Equipment Maintenance Kit /URMl.	6625-557-5716

88. Test Facilities

a. It is mandatory in electrically noisy areas that these tests be conducted in a screened room.

b. Connect the Radio Receiver R-390A/ URR chassis to a suitable ground for all tests.

c. The power source must be 115 or 230 volts ac, depending on the voltage for which the receiver is wired.

d. The location and labeling of certain controls and receptacles differ between R. F. Signal Generator Set AN/URM-25D and R. F. Signal Generator Set AN/URM-25F. Reference to controls and control settings in the charts below applies to R. F. Signal Generator Set AN/URM-25F. The corresponding controls and control settings for R. F. Signal Generator Set AN/URM-25D are included in parentheses immediately below or adjacent to those for R. F. Signal Generator Set AN/URM-25F. When R. F. Signal Generator Set AN/URM-25D is used in the audio distortion test (fig. 80), Cord CG-409/U is used in place of Telephone Plug PL-055-B.

e. Reference to RANGE switch selections in the chart applies to Electronic Multimeters TS-505A/U, TS-505B/U, TS-505C/U, and TS-505D/U. Corresponding control settings for the TS-505/U appear in parentheses immediately below or adjacent to those for the lettered models.

f. Reference to controls and control settings in the charts applies to Audio Oscillators TS-382B/U, TS-382D/U, and TS-382E/U. Corresponding controls or control settings that differ for the TS-382A/U appear in parentheses immediately below or adjacent to those for the TS-382B/U, the TS-382D/U, and the TS-382E/U.

g. The location and labeling of certain controls and connectors differ between Oscilloscopes OS-8A/U and OS-8C/U. Reference to controls and control settings in the chart applies to Oscilloscope OS-8C/U. The corresponding controls or control settings for Oscilloscope OS-8A/U are included in parentheses immediately below or adjacent to those for Oscilloscope OS-8C/U.

89. Modification Work Orders

The performance standards listed in the tests (para 90 and 97) assume that all procedures in the modification w o r k orders listed in Department of the Army Pamphlet 310-4 have been performed.

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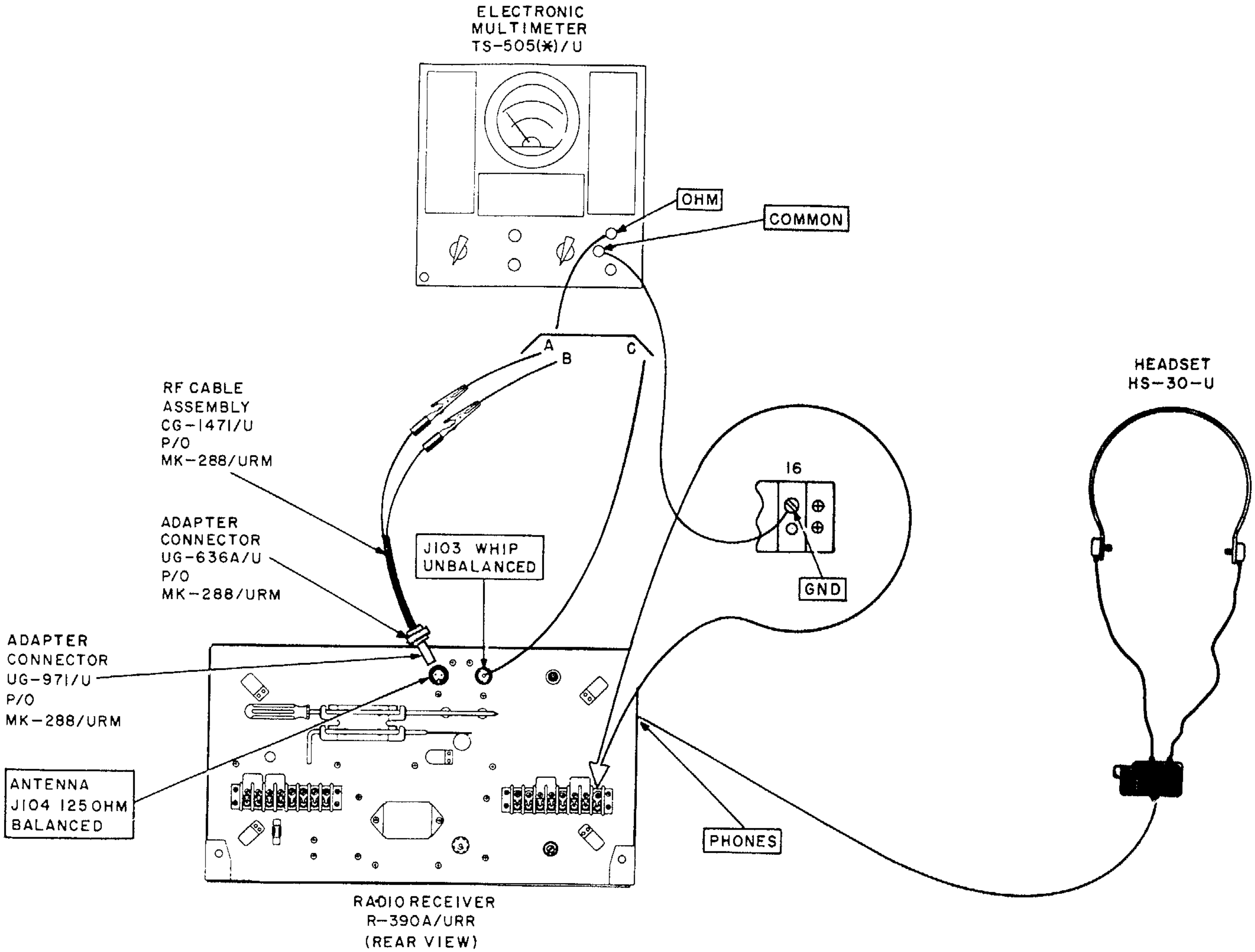

Figure 75. Calibration and antenna relay test setup.

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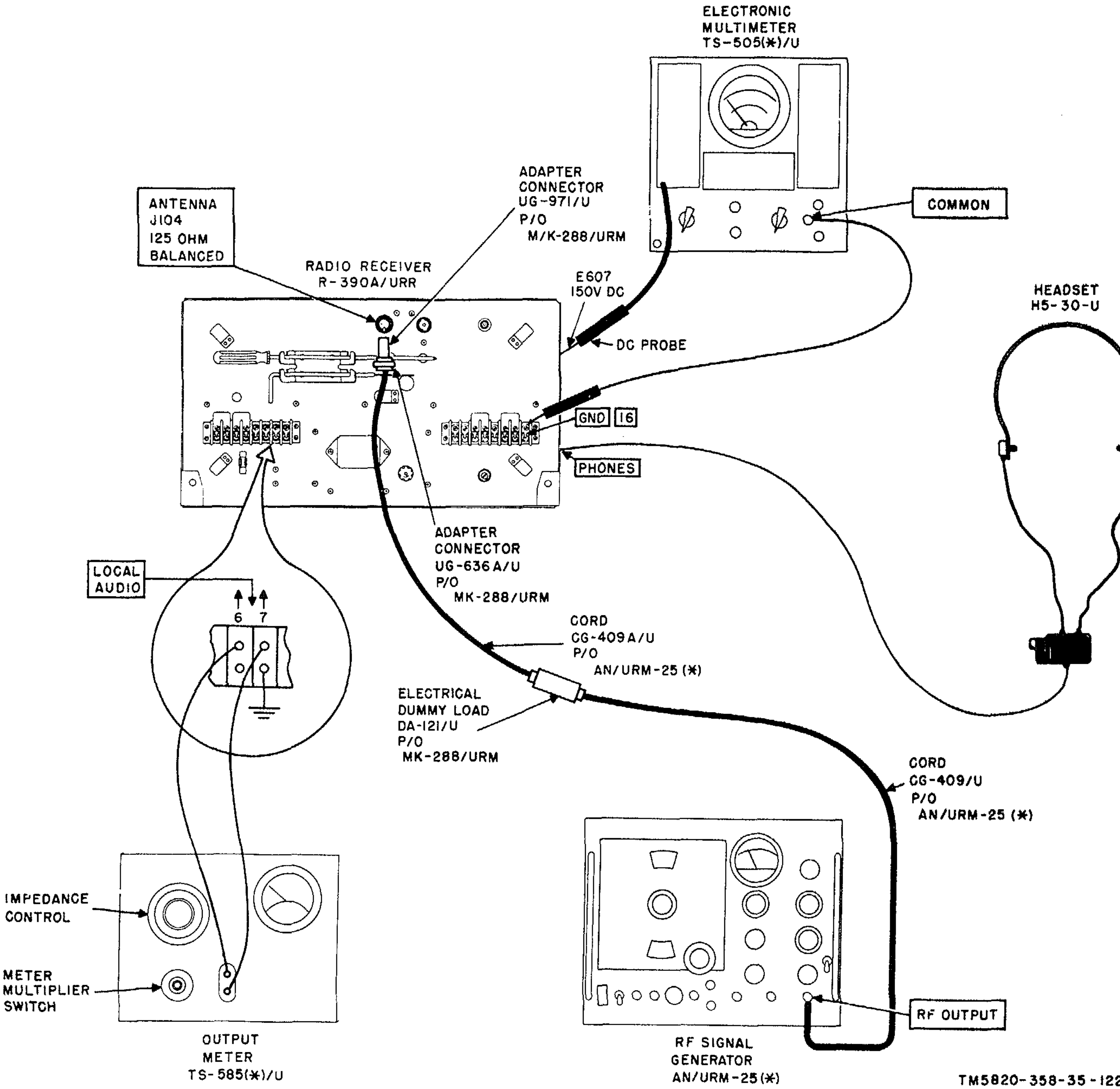

Figure 77. Sensitivity test setup.

90. Physical Tests and Inspection

a. Test Equipment and Materials. Electric Light Assembly MX-1292/PAQ.

b. Test Connections and Conditions. The check for the condition of mfp varnish should be made after repair and before assembly of the receiver. Connect the MX-1292/PAQ and install the wide transmission filter.

c. Test Procedure.

Step No.	Test equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	*MX-1292/PAQ* 245 V. FOR M.V. LAMP switch: ON	Controls may be in any position.	*a.* Expose to direct rays of lamp any portion of equipment that has been repaired. Note: There should be no varnish on variable capacitor plates, dial mechanisms, switch or relay contacts, or on connector contacts. *b.* Turn lamp off and proceed to next step.	*a.* All chassis surfaces and repaired components, parts, or connections will be covered with mfp varnish Note: Mfp varnish glows grayish green under mfp lamp. *b.* None.
2	None	Same as in step No. 1	Inspect equipment for modification work orders. Note any MWO procedure not performed.	All MWO procedures performed should be properly marked on receiver.
3	None	Same as in step No. 2	*a.* Check LOCAL GAIN, RF GAIN, ANT TRIM, LIMITER, LINE GAIN, and BFO PITCH controls for smooth operation, free from binding throughout their limits of travel. *b.* Check BANDWIDTH, BFO, AUDIO RESPONSE, LINE METER, AGC, BREAK IN, FUNCTION, and OVENS switches for correct operation. *c.* Adjust KILOCYCLE CHANGE control for indication of 500 on indicator. (Megacycle indicators may be at any setting.) Turn DIAL LOCK control to its extreme clockwise position (thumbtight). Attempt to turn KILOCYCLE CHANGE control position clockwise and counterclockwise. Observe kilocycles indicators. *d.* Disengage DIAL LOCK control. *e.* Turn KILOCYCLE CHANGE and MEGACYCLE CHANGE controls throughout their entire range of travel. Observe operation of controls.	*a.* All controls should operate freely without binding. *b.* All switches should operate freely without binding. Detent action should be positive. *c.* Kilocycle indicators should remain at 500. *d.* None. *e.* Controls should turn smoothly without binding or jamming. MEGACYCLE CHANGE control should have positive detent action at each megacycle setting.
4	None	Same as in step No. 1	*a.* Inspect LINE LEVEL and CARRIER LEVEL meters for broken glass or damaged pointers. *b.* Inspect frequency indicator panel for broken glass. *c.* Inspect all connectors, fuses, terminal boards, shorting bars, screwdriver, fluted socket wrench, and cover plates for damage, missing parts, or incorrect fuse ratings. Inspect case, front and rear, for missing screws, nuts, or bolts. *d.* Inspect receiver, front and rear, and dust covers, top and bottom; for physical damage (dents, punctures, or bent areas). *e.* Inspect receiver for condition of finish and panel markings.	*a.* Meters should be in good condition. *b.* Glass should be in good condition. *c.* None of listed items should be missing or damaged. Fuses should be of correct rating. *d.* There should be no dents, punctures, or bent areas. *e.* Painted surfaces should show no bare metal. Panel markings should be legible. *Do not paint rear panel.* Note: Whenever practicable, touchup painting is recommended instead of refinishing. Screwheads, receptacles, and carrying handles will not be painted or polished with abrasives.

91. Calibration and Antenna Relay Tests (fig. 75)

a. Test Equipment and Materials.

Headset HS-30-U
Electronic Equipment Maintenance Kit MK-288/URM
Electronic Multimeter TS-505(*)/U

b. Test Connections and Conditions. Turn on the TS-505(*)/U and allow it to warm up for 5 minutes. Do not connect the TS-505(*)/U until instructed to do so in the Test procedure column.

c. Test Procedure.

Step No.	Test equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	None	OVENS: OFF RF GAIN: 10 LINE METER: OFF LINE GAIN: 0 LIMITER: OFF AUDIO RESPONSE: WIDE FUNCTION: CAL BREAK IN: OFF BFO: ON AGC: MED BFO PITCH: 0 DIAL LOCK: unlocked ZERO ADJ: disengaged LOCAL GAIN: 0 MEGACYCLE CHANGE and KILOCYCLE CHANGE: set for 04 000 BANDWIDTH: .1	*a.* Adjust KILOCYCLE CHANGE and ANT TRIM controls for maximum indication on CARRIER LEVEL meter. Note setting of receiver frequency indicator. *b.* If frequency indicator does not indicate exactly 04 000, proceed as follows: otherwise continue to step No. 2. (1) Adjust KILOCYCLE CHANGE control for frequency indicator setting of 04 000. (2) Turn ZERO ADJ control fully clockwise. (3) Turn LOCAL GAIN control until audible tone is heard in headset. (4) Adjust KILOCYCLE CHANGE control slowly until zero beat is heard in headset and CARRIER LEVEL meter is at peak indication. Zero beat and peak indication must not change when KILOCYCLE CHANGE control is released. (5) Turn ZERO ADJ control fully counterclockwise. Note: BFO PITCH control *must* be at 0.	*a.* None. *b.* As follows: (1) None. (2) None. (3) None. (4) Peak indication must be obtained when frequency indicator is set at 04 000.
2	None	Same as in step No. 1, except: Set KILOCYCLE CHANGE and MEGACYCLE CHANGE as indicated in *Test procedure* column.	Repeat step No. 1 for frequencies listed below: 04 100 31 100 04 200 31 200 04 300 31 300 04 400 31 400 04 500 31 500 04 600 31 600 04 700 31 700 04 800 31 800 04 900 31 900 04+000 31+000 31 000	Same as in step No. 1*b*(4) except for frequency.
3	*TS-505(*)/U* FUNCTION: OHMS RANGE: R X 1	Same as in step No. 1.	*a.* Connect equipment (A, fig. 75). *b.* Turn receiver FUNCTION switch to STAND BY and CAL positions while observing TS-505(*)/U meter. *c.* Connect equipment (B, fig. 75). *d.* Repeat *b* above. *e.* Connect equipment (C, fig. 75), turn TS-505(*)/U RANGE switch to R X 10K. *f.* Repeat *b* above.	*a.* TS-505(*)/U indication is infinite. *b.* TS-505(*)/U indication is zero. Listen for antenna relay operation. *c.* TS-505(*)/U indication is infinite. *d.* Same as *b* above. *e.* TS-505(*)/U indication is 220K. *f.* Same as *b* above.

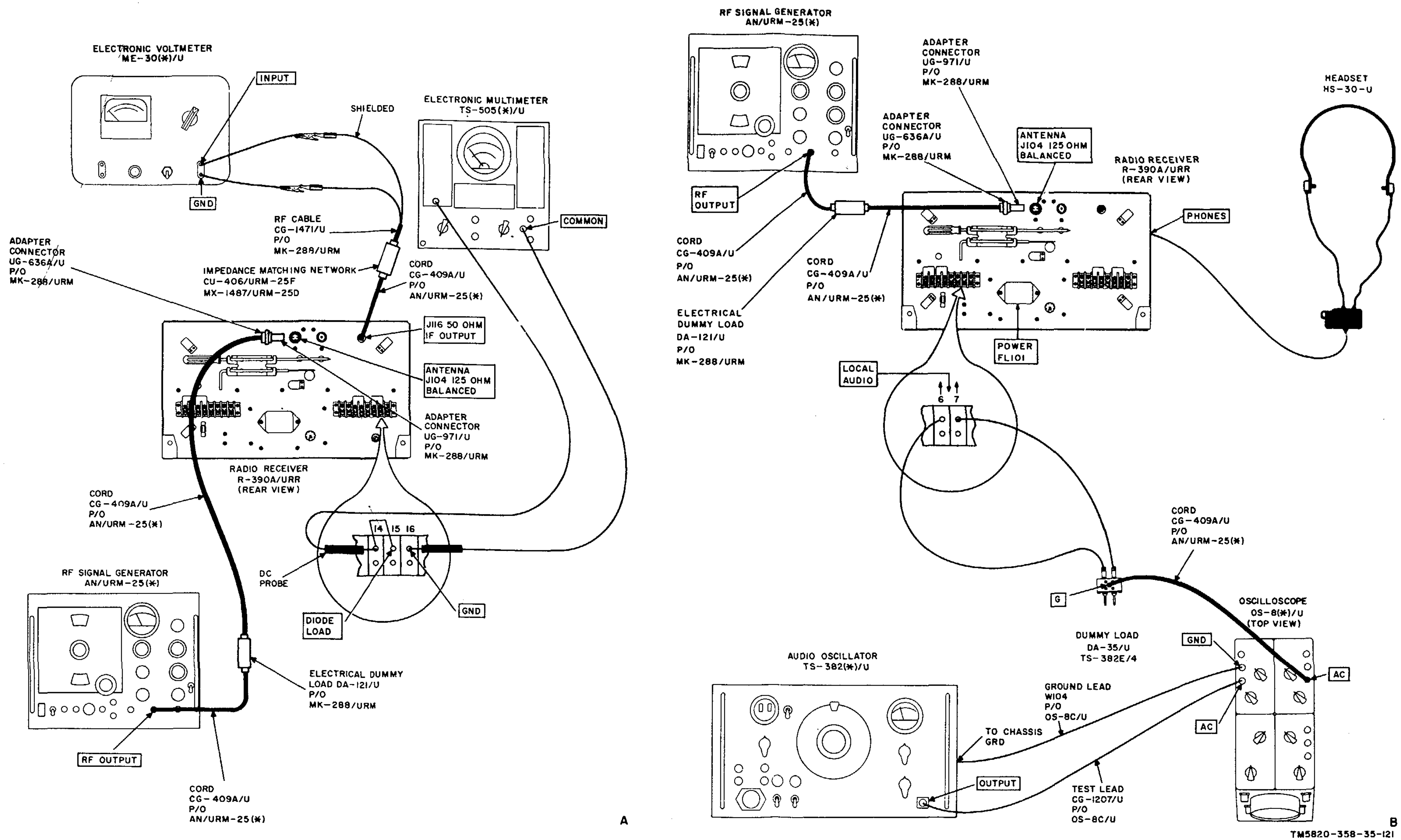

Figure 76. If. Output and bfo calibration test setup.

92. If. Output and Bfo Calibration Tests
(fig. 76)

a. *Test Equipment and Materials.*
R. F. Signal Generator Set AN/URM-25F
Electronic Equipment Maintenance Kit MK-288/URM
Electronic Voltmeter ME-30(*)/U
Oscilloscope OS-8(*)/U
Audio Oscillator TS-382(*)/U
Electronic Multimeter TS-505(*)/U
Headset HS-30-U

b. *Test Connections and Conditions.* Connect the equipment as shown in A, figure 76. Turn on all test equipment and allow a warmup time of 15 minutes.

c. *Test Procedure.*

Step No.	Test equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	*TS-505(*)/U* FUNCTION: -D.C. RANGE: 50 V (40 V) *ME-30(*)/U* RANGE selector switch: .3 VOLTS *AN/URM-25F* ATTENUATOR: 10 R.F. MULTIPLIER: (X10) FUNCTION SWITCH: CW (MOD. XTAL. & METER SELECTOR: CS) (Carrier range switch: 300KC-50MC X MULT) SET RF OUTPUT: max ccw (Carrier control: max ccw) %MOD AUDIO OUT LEVEL: max ccw MICROVOLTS: MAX (max cw) BAND SWITCH: 1.5.-3.8 (Frequency band switch: .95-3.0 MC) TUNING: 1.15 MC (Main tuning dial: 1.51)	RF GAIN: 10 LINE METER: OFF LINE GAIN: 0 AGC: MED. LIMITER: OFF AUDIO RESPONSE: WIDE BANDWIDTH: 8 BFO PITCH: 0 BREAK IN: OFF FUNCTION: MGC ANT TRIM: 0 BFO: OFF DIAL LOCK: unlocked ZERO ADJ: disengaged LOCAL GAIN: 5 OVENS: OFF MEGACYCLE CHANGE and KILOCYCLE CHANGE: set for 01 510	*a.* Adjust AN/URM-25F SET RF OUTPUT control (carrier control) clockwise until meter indicates full scale (10). *b.* Turn AN/URM-25F MICROVOLTS control ccw until meter indicates 3 microvolts (top scale). *c.* Adjust AN/URM-25F TUNING control (main tuning dial) for maximum TS-505(*)/U indication. Adjust receiver ANT TRIM control for maximum TS-505(*)/U indication. *d.* Turn receiver RF GAIN control to zero. *e.* Turn ME-30(*)/U RANGE selector switch to .1 VOLTS. *f.* Adjust receiver RF GAIN control for indication of 20 millivolts on ME-30(*)/U meter (.2 R.M.S. VOLTS, top scale). *g.* Set AN/URM-25F ATTENUATOR (R.F. MULTIPLIER) to 100. Adjust MICROVOLTS control for 30 microvolts indication on meter (3, top scale). *h.* Note and record indication on ME-30(*)/U meter. *i.* Disconnect ME-30(*)/U and TS-505(*)/U and proceed to next step.	*a.* None. *b.* None. *c.* None. *c.* None. *e.* None. *f.* None. *g.* None. *h.* ME-30(*)/U indication should be between 180 and 220 millivolts. *i.* None.
2	Same as in step No. 1 except: *TS-382(*)/U* OUTPUT CONTROL: max ccw OUTPUT MULTIMETER: X .1 VOLTS (ATTENUATOR: .1) FREQUENCY MULTIPLIER: X100 (RANGE: X100) Main tuning dial: 30 *OS-8(*)/U* OFF-INT: on cw position (INTENSITY: on) VERNIER FREQUENCY: 20 (SWEEP VERNIER: 20) COARSE FREQUENCY: 2900/17.5 KC SWEEP RANGE: 2 KC-10 KC) HOR. ATTEN. (C model only): SWEEP VERT. GAIN: 60 (Y GAIN: 60) HOR. GAIN: 30 (X GAIN: 30) VERT. ATTEN.: 100 (VERT. ATTEN.: AC 100:1) SYNC SELECTOR: INT. LOCKING: 0 (SYNC AMPLITUDE: 0)	Same as in step No. 1 LOCAL GAIN: 3	*a.* Connect equipment as shown in B, figure 76. *b.* Adjust AN/URM-25F SET RF OUTPUT control (carrier control) for full-scale indication on meter (10). *c.* Turn receiver BFO switch to ON and adjust KILOCYCLE CHANGE control for zero beat in HS-30-U. *d.* Adjust all controls on front panel of OS-8(*)/U for clear, sharply defined, and centered trace. *e.* Set BFO PITCH control to -3 and adjust OS-8(*)/U VERNIER FREQUENCY (SWEEP VERNIER) control until one sine wave is obtained on scope. *f.* Set OS-8(*)/U HOR. ATTEN. (OS-8C/U only) to 1. *g.* Adjust TS-382(*)/U OUTPUT CONTROL (OUTPUT LEVEL control) clockwise until TS-382(*)/U meter indicates 1.0. Adjust TS-382(*)/U main tuning dial *until circular pattern is obtained on* OS-8(*)/U. Note and record setting of main tuning dial. *h.* Turn BFO PITCH control to +3. Reset TS-382(*)/U main tuning dial for circular pattern on OS-8(*)/U. *i.* Turn receiver BANDWIDTH switch to .1, FUNCTION switch to CAL, and BFO switch to OFF. Adjust KILOCYCLE CHANGE control for 01 500 indication on frequency indicator dial. *j.* Adjust KILOCYCLE CHANGE and ANT TRIM controls for maximum indication on receiver CARRIER LEVEL meter. *k.* Turn BFO switch to ON and adjust BFO PITCH control for zero beat in HS-30-U headset. Note setting of BFO PITCH control.	*a.* None. *b.* None. *c.* None. *d.* None. *e.* None. *f.* None. *g.* TS-382(*)/U main tuning dial setting should be between 24 and 36. *h.* Same as in step 2*g*. *i.* None. *j.* None. *k.* BFO PITCH control should be at 0 setting when zero beat is obtained.

93. Sensitivity Test
(fig. 77)

a. *Test Equipment and Materials.*
Electronic Multimeter TS-505(*)/U
Output Meter TS-585(*)/U
Electronic Equipment Maintenance Kit MK-288/URM
R. F. Signal Generator Set An/URM-25F
Headset Hs-30-U

b. *Test Connections and Conditions.* Connect the equipment as shown in figure 77. Do not connect the TS-505(*)/U until instructed to do so in the Test procedure column.

c. *Test Procedure.*

Step No.	Test equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	*TS-505(*)/U* FUNCTION: +D.C. RANGE: 250 V (400 V) *AN/URM-25F* ATTENUATOR: 10 (R.F. MULTIPLIER: X 10) MICROVOLTS: MAX (max cw) FUNCTION SWITCH: CW (MOD. XTAL & METER SELECTOR: CW) %MOD AUDIO OUT LEVEL: max ccw SET RF OUTPUT: max ccw (Carrier control: max) (Carrier range switch: 300KC-50MC X MULT) BANDSWITCH: 0.6-1.5 (Frequency band switch: 300-950KC) TUNING: .750 (Main tuning dial: .750) *TS-585(*)/U* Impedance control: 60 X 10 Meter multiplier switch: 100	OVENS: OFF LOCAL GAIN: 10 RF GAIN: 10 BREAK IN: OFF LIMITER: OFF BFO PITCH: 0 AGC: MED BFO: ON BANDWIDTH: 16 AUDIO RESPONSE: MED LINE METER: OFF FUNCTION: MGC MEGACYCLE CHANGE and KILOCYCLE CHANGE: set for 00 750 LINE GAIN: 0	*a.* Short TS-505(*)/U DC and COMMON probe tips together, and turn ZERO ADJ control until meter pointer indicates exactly 0 volt. Connect TS-505(*)/U as shown in figure 77. *b.* Note and record indication on TS-505(*)/U meter. *c.* Disconnect TS-505(*)/U from receiver. *d.* Turn AN/URM-25F SET RF OUTPUT (carrier control) control clockwise until AN/URM-25F meter indicates full scale (10). *e.* Adjust receiver ANT TRIM control for peak indication on TS-585(*)/U meter. Adjust AN/URM-25F main tuning dial for peak TS-585(*)/U indication. *f.* Turn receiver BFO switch OFF and AN/URM-25F MICROVOLTS control max ccw. *g.* Set TS-585(*)/U meter multiplier switch to 1. *h.* Adjust receiver LOCAL GAIN control for 1 milliwatt indication on TS-585(*)/U meter. *i.* Turn AN/URM-25F FUNCTION SWITCH to 400 and adjust % MOD AUDIO OUT LEVEL control for indication of 30 on % MOD scale of AN/URM-25F meter. *j.* Turn AN/URM-25F MICROVOLTS control clockwise until TS-585(*)/U meter indicates 10 milliwatts. *k.* Adjust receiver ANT TRIM control for peak indication on TS-585(*)/U meter. *l.* Set AN/URM-25F FUNCTION SWITCH to CW. Readjust receiver LOCAL GAIN control for 1 milliwatt indication on TS-585(*)/U meter. *m.* Turn AN/URM-25F FUNCTION SWITCH to 400 and readjust MICROVOLTS control for 10 milliwatt indication on TS-585(*)/U meter. *n.* Repeat *l* and *m* above, if necessary, until TS-585(*)/U meter indicates 1 milliwatt with AN/URM-25F FUNCTION SWITCH in CW position, and 10 milliwatts in 400 position. *o.* Set AN/URM-25F FUNCTION SWITCH to CW; observe and note AN/URM-25F meter indication.	*a.* None. *b.* TS-505(*)/U meter should indicate between 146 and 154 vdc. *c.* None. *d.* None. *e.* None. *f.* None. *g.* None. *h.* None. *i.* None. *j.* None. *k.* None. *l.* None. *m.* None. *n.* None. *o.* AN/URM-25F meter should indicate not more than 4.0 microvolts.
2	Same as in step No. 1 except: *AN/URM-25F* BANDSWITCH: 3.8-10 (Frequency band switch: 3.0-915 MC) TUNING: 6.0 (Main tuning dial: 6.0)	Same as in step No. 1 except: MEGACYCLE CHANGE and KILOCYCLE CHANGE: set for 06 000.	Repeat step No. 1*d* through *o* above.	Same as in step No. 1
3	Same as in step No. 1 except: *AN/URM-25F* BANDWSITCH: 10-25 (Frequency band switch: 9.5-30 MC) TUNING: 14.0 (Main tuning dial: 14.0)	Same as in step No. 1 except: MEGACYCLE CHANGE and KILOCYCLE CHANGE: set for 14 000.	Repeat step No. 1*d* through *o* above.	Same as in step No. 1
4	Same as in step No. 1 except: *AN/URM-25F* BANDSWITCH: 25-50 (Frequency band switch: 9.5-30 MC) TUNING: 20 (Main tuning dial: 20)	Same as in step No. 1 except: MEGACYCLE CHANGE and KILOCYCLE CHANGE: set for 20 000.	Repeat step No. 1*d* through *o* above.	Same as in step No. 1*d* through *n* above. *o.* AN/URM-25F meter should indicate not more than 5.0 microvolts.
5	Same as in step No. 1, except: *AN/URM-25F* BANDSWITCH: 25-50 (Frequency band switch: 9.5-30 MC) TUNING: 26 (Main tuning dial: 26)	Same as in step No. 1, except: MEGACYCLE CHANGE and KILOCYCLE CHANGE: set for 26 000	Repeat step No. 1*d* through *o* above.	Same as in step No. 4.
6	Same as in step No. 1, except: *AN/URM-25F* BANDSWITCH: 25-50 (Frequency band switch: 9.5-30 MC) TUNING: 30 (Main tuning dial: 30)	Same as in step No. 1, except MEGACYCLE CHANGE and KILOCYCLE CHANGE: set for 30 000.	Repeat step No. 1*d* through *o* above.	Same as in step No. 4.
7	Same as in step No. 1, except: *AN/URM-25F* ATTENUATOR: 1 (R.F. MULTIPLIER: X I)	Same as in step No. 1.	*a.* Turn AN/URM-25F SET RF OUTPUT (carrier) control until meter indicates full scale (10). *b.* Adjust receiver ANT TRIM control for peak indication on TS-585(*)/U meter. *c.* Adjust receiver KILOCYCLE CHANGE control for dip in TS-585(*)/U meter indication and zero beat in headset. *d.* Turn AN/URM-25F MICROVOLTS control max ccw, and receiver BFO switch to OFF. *e.* Set TS-585(*)/U meter multiplier switch to 1 and adjust receiver LOCAL GAIN control for 1-milliwatt indication on TS-585(*)/U meter. *f.* Adjust AN/URM-25F MICROVOLTS control until TS-585(*)/U meter indicates 10 milliwatts. Note and record AN/URM-25F meter indication. (MICROVOLTS scale). *g.* Repeat step 7*a* through *f* for frequencies indicated below. Use control settings as indicated in *Test equipment control settings* columns of steps 2 through 6, respectively, but leave ATTENUATOR on 1 for AN/URM-25F. Frequencies (mc) 6 14 20 26 30	*a.* None. *b.* None. *c.* None. *d.* None. *e.* None. *f.* AN/URM-25F meter should indicate not more than 1 microvolt. *g.* Same as in step No. 7*f*.

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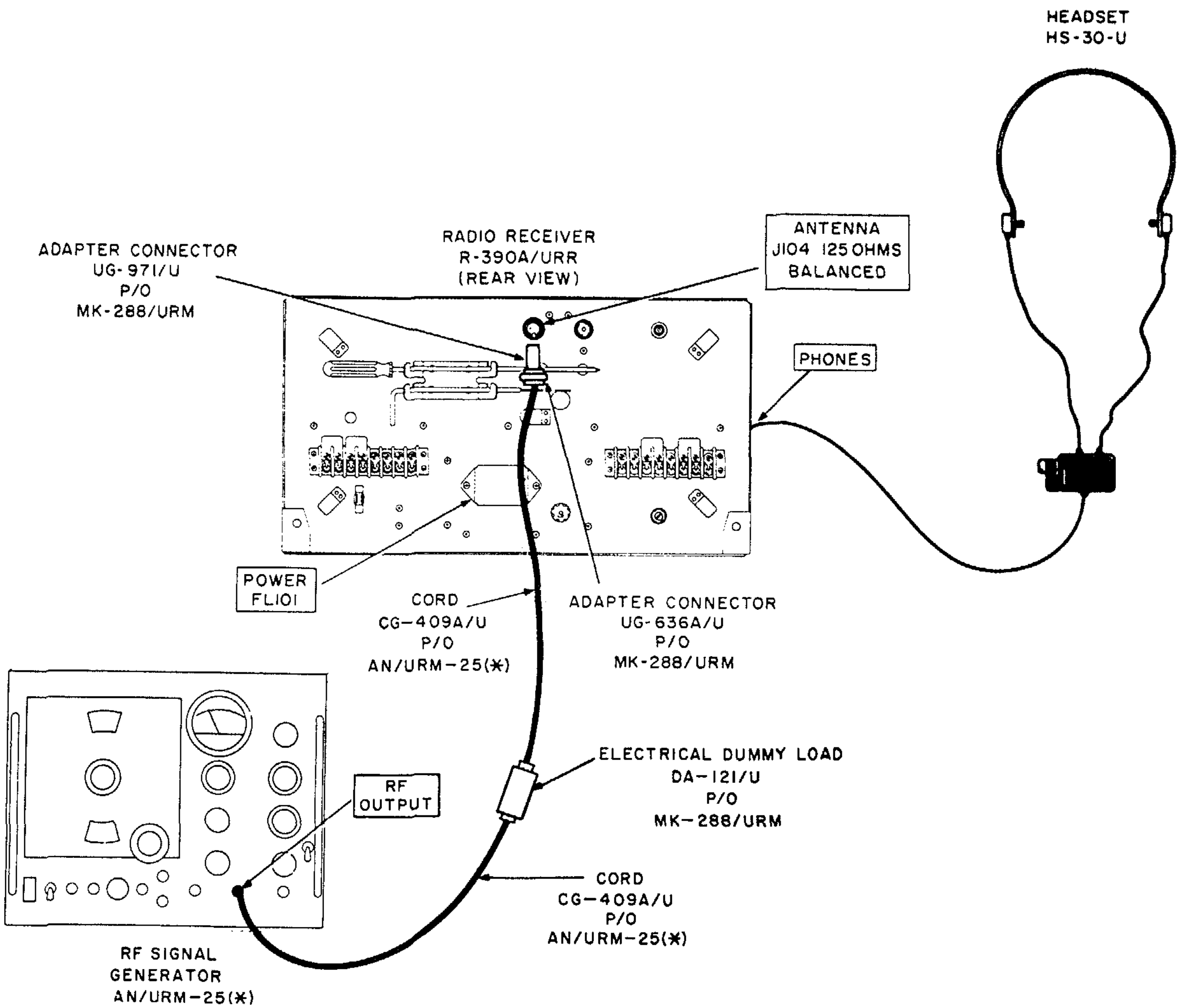

Figure 78. Line level meter and limiting test setup.

94. Line Level Meter and Noise-Limiter Tests
(fig. 78)

a. Test Equipment and Materials.

Headset HS-30-U
Electronic Equipment Maintenance Kit MK-288/URM
R. F. Signal Generator Set AN/URM-'25F

b. Test Connections and Conditions. Connect the equipment as shown in figure 78.

c. *Test Procedure.*

Step No.	Test equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	*AN/URM-25F* BANDSWITCH: 3.8-10 (Frequency band switch: 9.5-30 MC) FUNCTION SWITCH: CW (MOD. XTAL & METER SELECTOR: CW) % MOD AUDIO OUT LEVEL: max ccw MICROVOLTS: MAX (MICROVOLTS: max cw) ATTENUATOR: 10 (R.F. MULTIPLIER: X 10) SET RF OUTPUT: max cow (Carrier control: max cow) (Carrier range switch: 300KC-50 MC X MULT) TUNING: 10 (Main tunning dial: 10)	ANT TRIM: 0 OVENS: OFF RF GAIN: 10 LINE METER: -10 LINE GAIN: 0 LIMITER: OFF AUDIO RESPONSE: WIDE FUNCTION: MGC BREAK IN: OFF BFO: ON AGC: MED DIAL LOCK: unlocked ZERO ADJ: disengaged LOCAL GAIN: 0 MEGACYCLE CHANGE and KILOCYCLE CHANGE: set for 10 000 BANDWITH: 8 kc	*a.* Adjust LOCAL GAIN and BFO PITCH controls for audible tone from HS-30-U headset. *b.* Adjust LINE GAIN control for zero vu indication on LINE LEVEL meter (top scale). *c.* Turn LINE METER switch to 0. Note and record LINE LEVEL meter indication (top scale). *d.* Readjust LINE GAIN control for zero vu indication on LINE LEVEL meter (top scale). *e.* Turn LINE METER switch to +10. Note and record LINE LEVEL meter indication (top scale). *f.* Adjust LINE METER and LINE GAIN controls for full-scale deflection (+3 VU marking on top scale) of LINE LEVEL meter. *g.* Turn LIMITER control to position 1. (LINE LEVEL meter indication will decrease.) Readjust LINE GAIN control for full-scale indication. *h.* Slowly turn LIMITER control clockwise to position 10, while observing LINE LEVEL meter. Note: Readjust LINE GAIN control as required to maintain indication on LINE LEVEL meter until LIMITER con- to position 10.	*a.* None. *b.* None. *c.* LINE LEVEL meter should indicate -10 VU. *d.* None. *e.* LINE LEVEL meter should indicate -10 VU. *f.* None. *g.* None. *h.* LINE LEVEL meter indication should decrease smoothly with no abrupt changes as LIMITER control is advanced

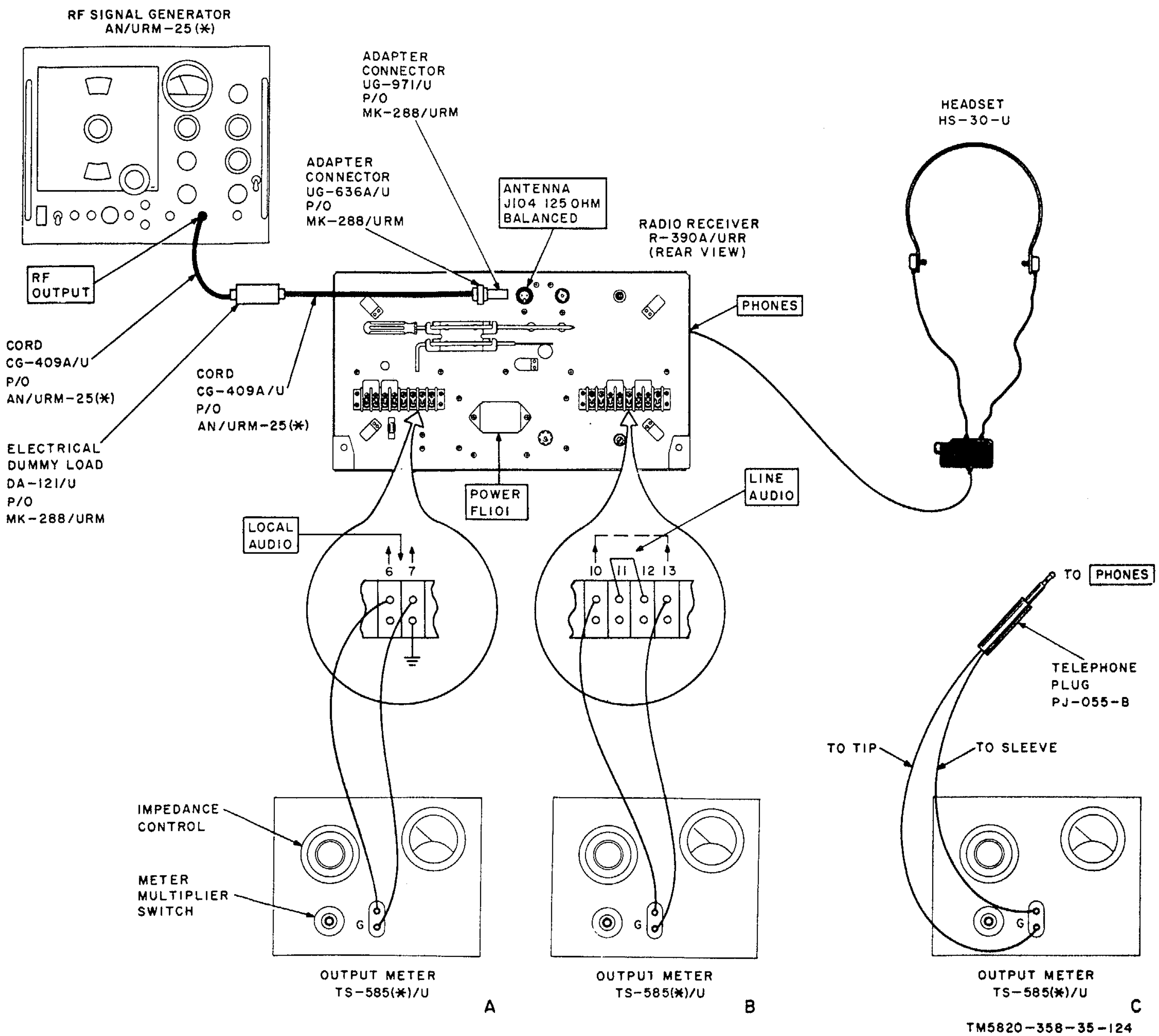

Figure 79. output test setup.

95. Audio Output Tests
(fig. 79)

a. Test Equipment and Materials.
Output Meter TS-585(*)/U
R. F. Signal Generator Set AN/URM-25F
Electronic Equipment Maintenance Kit MK-288/URM
Telephone Plug PJ-055-B

b. Test Connections and Conditions. Connect the equipment as shown in A, figure 79.

c. Test Procedure.

Step No.	Test equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	*TS-585(*)/U* Impedance control: 60 X 10 A.N/URM 25F ATTENUATOR: 10 (R.F. MULTIPLIER: X 10) FUNCTION SWITCH: CW (MOD. XTAL & METER SELECTOR: CW) SET IRF OUTPUT: max ccw (Carrier control: max ccw) (Carrier range switch: 3001(C-50MC X MULT) %0 MOD AUDIO OUT LEVEL: max ccw MICROVOLTS: NMAX (MICROVOLTS: max cw) BAND SWITCH: 1.5-3.8 (Frequency band switch: .95-3.0 NMC) TUNING: 1.50 (tuning dial: 1.50)	OVENS: OFF RF GAIN: 10 LINE METER: 0 LINE GAIN: 0 LIMITER: OFF AUDIO RESPONSE: WIDE FUNCTION: AGC BREAK IN: OFF BFO: ON AGC: MED BFO PITCH: 0 DIAL LOCK: unlocked ZERO ADJ: disengaged LOCAL GAIN: 10 MEGACYCLE CHANGE and KILOCYCLE CHANGE: set for 01 500 BANDWITH: 8 kc ANT TRIM: 0	*a.* Adjust AN/URM-25F SET RF OUTPUT (carrier) control until AN/URM-25F meter indicates full scale (10). *b.* Adjust receiver LINE GAIN control until full-scale indication is obtained on LINE LEVEL meter. *c.* Adjust AN/URM-25F TUNING (main tuning dial) for full (zero beat) indication on LINE LEVEL meter (0 lower-scale indication). *d.* Turn receiver BFO switch to OFF. *e.* Turn AN/URM-25F FUNCTION SWITCH (MOD. XTAL & METER SELECTOR) to 400 and adjust % MOD AUDIO OUT LEVEL control for 30% indication on AN/URM-25F meter. *f.* Note and record indication on TS-585(*)/U meter. *g.* Turn LINE GAIN control fully clockwise and LINE METER switch to OFF. Reconnect TS-585(*)/U as shown in B, figure 79. *h.* Set TS-585(*)/U meter multiplier switch to 1. Note and record TS-585(*)/U meter indication. *i.* Reconnect TS-585(*)/U as shown in C, figure 79. Note and record the TS-585(*)/U meter indication.	*a.* None. *b.* None. *c.* None. *d.* None. *e.* None. *f.* TS-585(*)/U meter should indicate not less than 450 milliwatts. *g.* None. *h.* TS-585(*)/U meter should indicate not less than 9 milliwatts. *i.* TS-585(*)/U meter should indicate not less than 4.5 milliwatts.

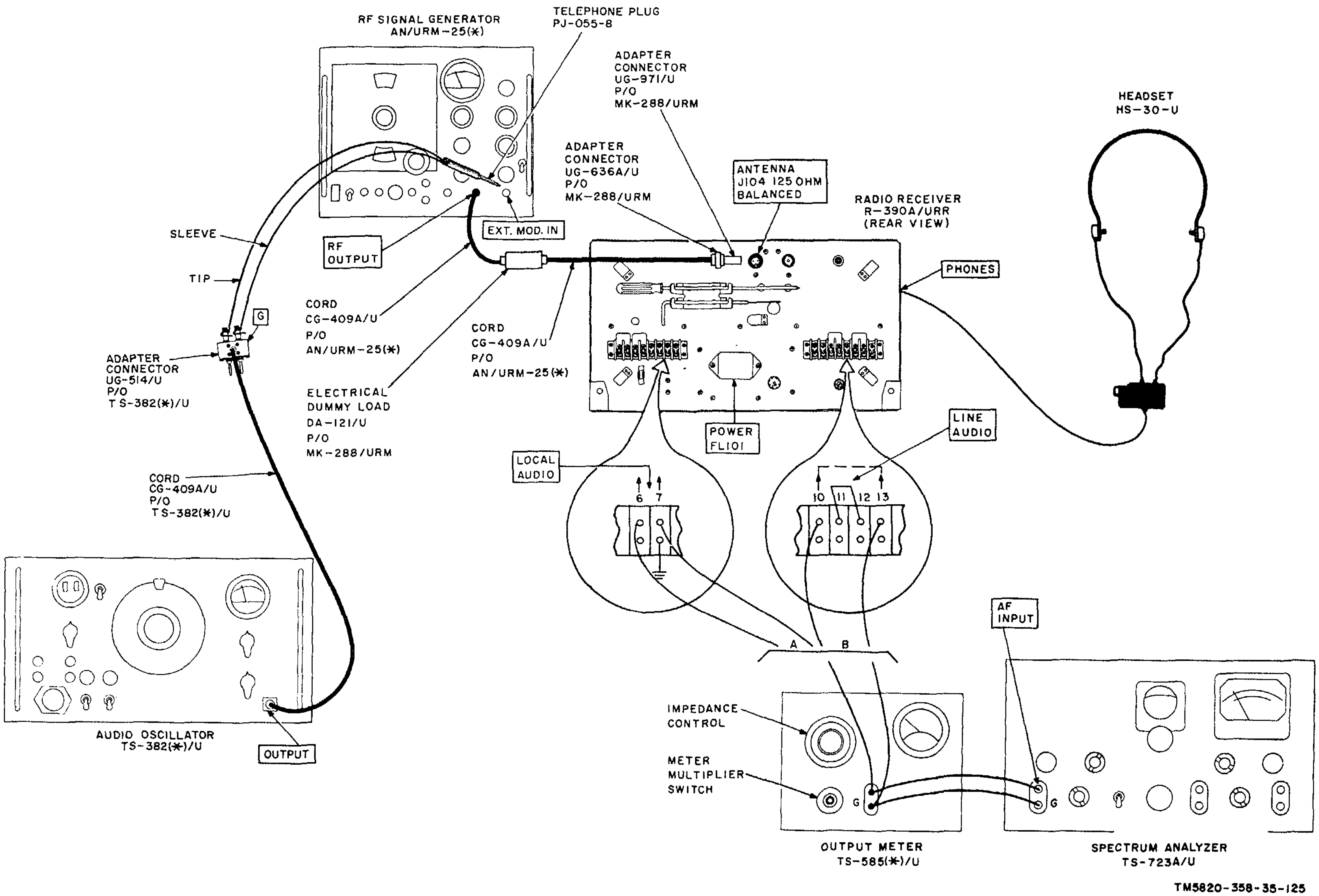

Figure 80. Audio distortion tests setup.

96. Audio Distortion Test
(fig. 80)
a. Test Equipment and Materials.
Spectrum Analyzer TS-723A/U
Headset HS-30-U
Telephone Plug PJ-055-B
Audio Oscillator TS-382(*)/U
R. F. Signal Generator Set AN/URM-25F Output Meter TS-585(*)/U
Electronic Equipment Maintenance Kit MK-288/URM

b. Test Connections and Conditions. Connect the equipment *as shown in* A, *figure 80.* Turn the TS-723A/u on and allow it to warm up for 10 minutes.

c. Test Procedure.

Step No.	Test equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	TS-723A/U AF-RF: AF INPUT: MIN FREQ RANGE: X 10 FREQUENCY: 100 on tuning dial Function switch: SET LEVEL BALANCE: max ccw TS-382(*)/ U FREQUENCY MULTIPLIER: X 10 (RANGE: X 10) OUTPUT MULTIPLIER: X 10 VOLTS (ATTENUATOR: 10) OUTPUT CONTROL: max ccw (OUTPUT LEVEL control: max ccw) Main tuning dial: 100 TS-585(*)/U' Impedance control: 60 X 10 Meter multiplier switch: 100 A N URM-25F ATTENUATOR: 10 (R.F. MULTIPLIER: X 10) FUNCTION SWITCH: CW (MOD. XTAL & METER SELECTOR: CW) SET RF OUTPUT: max ccw (Carrier control: max ccw) (Carrier range switch: 800KG-50 MC X MULT) % MOD AUDIO OUT LEVEL: max:: ccw MICROVOLTS: MAX (MICROVOLTS: max cw) BANDSWITCH: 1.5-8.8 MEGACYCLES TUNING: 1.50 (Frequency band switch: .95-3.0 MC) (Main tuning dial: 1.50)	OVENS: OFF RF GAIN: 10 LINE METER: OFF LINE GAIN: 10 LIMITER: OFF AUDIO RESPONSE: WIDE FUNCTION: AGC BREAK IN: OFF BFO: ON AGC: MED BFO PITCH: 0 DIAL LOCK: unlocked ZERO ADJ: disengaged LOCAL GAIN: 10 MEGACYCLE CHANGE and KILOCYCLE CHANGE: set for 500 BANDWIDTH: S kc ANT TRIM: 0	*a.* Adjust AN/URM-25F SET RF OUTPUT (carrier control) until AN/URM-25F meter indicates full scale (10). *b.* Adjust AN/URM-25F TUNING (main tuning dial) for zero beat in HS-80-U. Turn receiver BFO switch to OFF. Set AN/URM-25F FUNCTION SWITCH (MOD. XTAL & METER SELECTOR) to EXT. *c.* Adjust TS-382(*)/U OUTPUT CONTROL (output level control) until TS-382(*)/U meter indicates 1.0. *d.* Adjust AN/URM-25F % MOD AUDIO OUT LEVEL control until AN/URM-25F meter indicates 30% MOD. *e.* Measure distortion; use following procedure: (1) Slowly rotate TS-728A/U INPUT control clockwise until TS-723A/U meter indicates full-scale deflection (1.0). (2) Turn TS-728A/U function switch to DISTORTION. (3) Adjust TS-728A/U upper FREQUENCY control (coarse) until sharp dip is indicated by meter needle. (4) Decrease meter range switch setting to maintain near-midscale indications. (5) Adjust lower FREQUENCY control (fine) for minimum meter indication. (6) Adjust BALANCE control for minimum meter indication. (7) Note and record distortion as indicated on TS-728A/U meter. (Read scale corresponding to meter range switch setting.)	*a.* None. *b.* None. *c.* None. *d.* None *e.* Distortion should not exceed 10%
2	No change from last positions of step No. I, except: TS-585(*)/U Meter multiplier switch: TS-723A/U AF-RF: AF INPUT: MIN. FREQ RANGE: X 10 FREQUENCY: 100 on tuning dial Function switch: SET LEVEL Meter range switch: 100% BALANCE: max ccw	No change from last positions in step No.1.	*a.* Connect TS-585(*)/U as shown in B, figure 80 and repeat step No. 1e. *b.* Turn off test equipment and remove all test connections from receiver.	*a.* Distortion should not exceed 6%. *b.* None.

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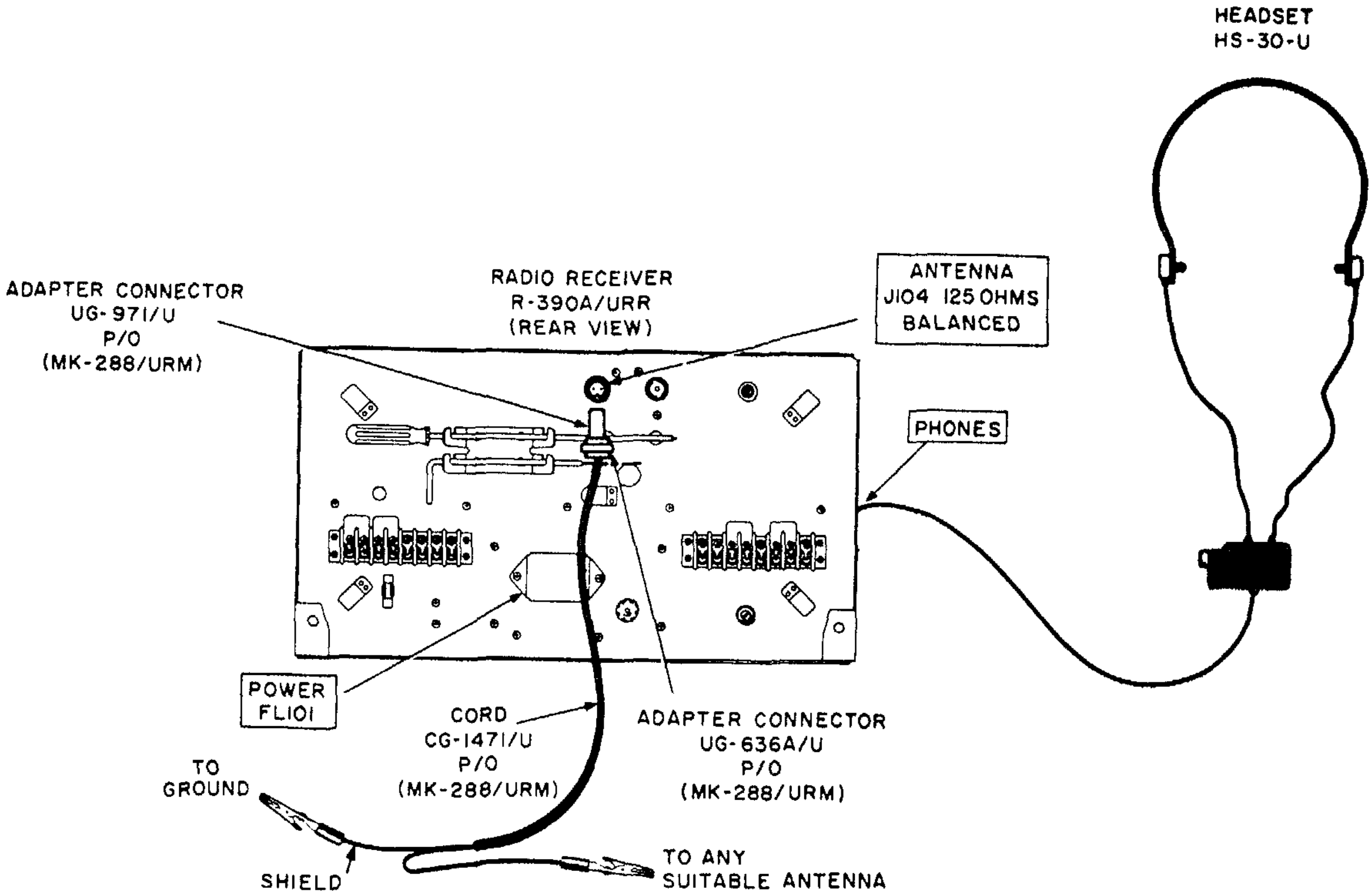


Figure 81. Operating tests setup.

97. Operational Tests

(fig. 81)

a. *Test Equipment and Materials.*

Headset HS-30-U

Electronic Equipment Maintenance Kit MK-2 88 /URM

b. Test Connections and Conditions. Connect the equipment as shown in figure 81. Dial indicators should light.

c. Test Procedure.

Step No.	Test equipment control settings	Equipment under test control settings	Test procedure	Performance standard
1	None	OVENS: OFF LINE METER: OFF LINE GAIN: 0 RF GAIN: 10 ACC: FAST LIMITER: OFF AUDIO RESPONSE: WIDE BANDWIDTH: 16 ka BFO PITCH: 0 BREAK IN: OFF FUNCTION: ACC ANT TRIM: 0 BFO: OFF DIAL LOCK: unlocked ZERO ADJ: disengaged LOCAL GAIN: 5	*a.* Adjust KILOCYCLE CHANGE and MEGACYCLE CHANGE controls to obtain any local broadcast station or station WWV.	a. None.
			b. Turn BFO switch to ON and adjust CYCLE CHANGE control for zero beat in 115-30-U. Turn BFO switch to OFF.	b. None.
			c. Adjust ANT TRIM control for maximum indication on CARRIER LEVEL meter.	c. None.
			d. While observing CARRIER LEVEL meter indication, turn AGC switch to MED.	d. No change should occur in CARRIER LEVEL meter indicator
			e. While observing CARRIER LEVEL meter indication, turn AGC switch to FAST.	e. CARRIER LEVEL meter indication should momentarily decease, and then return to its original indication.
			f. While observing CARRIER LEVEL meter indication and listening to HS-30-U output, turn AGC switch to MED.	f. Output from '15-80-U should cutout and CARRIER LEVEL meter should indicate full scale for approximately 4 seconds; then both should return to their original indications. Note.- check 4-second cutout period by counting 1-100, 2-:100, 3-100, 4-100, starting when AGC switch is turned to MED.
			g. Turn BANDWIDTH switch to each of its positions and listen to 115-80-U output,	g. Background noise should decrease with each change to next smaller bandwidth setting (Amplitude of output will also decrease
			h. Set BANDWIDTH switch to 8 kc position. at smaller bandwidth settings.)	h. None.
			i. Turn AUDIO RESPONSE switch to MED and listen to HS-80-U output.	i. There should be decrease in background noise.
			j. Turn AUDIO RESPONSE switch to SHARP and listen to HS-30-U output.	j. Fidelity of output should decrease.
			k. Turn AUDIO RESPONSE switch to MED.	k. None.
			l. Listen to output of HS-80-U and observe CARRIER LEVEL meter indication; turn FUNCTION switch to MGC.	l. Noise level in output of HS-80-U and CARRIER LEVEL meter indication should increase.
			m. Turn FUNCTION switch to AGC.	m. None.
			n. Short out antenna input and turn RF GAIN control to 0. Observe CARRIER LEVEL meter indication.	n. CARRIER LEVEL meter should indicate 0
			o. Turn FUNCTION switch to OFF, and disconnect test equipment from re-	o. None

98. Performance Standard Summary

Function	*Performance standard*
IF output	180-220 mv
BFO calibration	2,400-3,6000 cps
Regulated B+ voltage	146-154 volts do
AM sensitivity (10/1 signal plus noise-to-noise ratio)	
Frequency	
0.750 me	4.0 uv max
6.0	mc 4.0 uv max
14.0	me 4.0 uv max
20.0	mc 5.0 uv max
26.0	mc 5.0 uv max
30.0	me 5.0 uv max
CW sensitivity (10/1 signal 1.0 uv plus noise-to-noise ratio)	
Audio output	
Local audio	450 mw min
Line audio	9 mw min
Phones	4.5 mw min
Audio distortion	
Local audio	10% max
Line audio	6% max

99. Disassembly of Rf Gear Train Assembly

(fig. 88)

Under certain circumstances, such as gear damage, it may be necessary to disassemble and reassemble all or part of the gear train assembly. Do not disassemble parts that can be removed as an assembly unless the defect is in one of the assembly parts. For example, parts No. 1 through 6 of the riveted locking plate assembly need not be disassembled if the defect is in some other portion of the rf gear train assembly.

The instructions given should be used as a guide when the method of removal and replacement of parts is not obvious. The numbers used in the instructions refer to those that identify the parts in figure 88. When disassembling the rf gear train assembly, lay out the parts in the order of disassembly. This will simplify reassembly. Refer to paragraph 103 to identify items in figure 88. Proceed as follows:

a. Remove the front panel (para 58b).

b. Remove the 8 slug racks and 16 tension springs (para 63a).

c. Remove the rf subchassis (para 59b) and the crystal-oscillator subchassis (para 60b).

d. Set the frequency indicator to 07 +000.

e. Loosen the socket-head screw (20) and square nut (5) of the gear clamp (6).

f. Remove the riveted locking plate (1) and spur gear (2). If necessary, separate the riveted locking plate (1) and the spur gear (2) and remove the two rack gear springs (3) (only one shown) and the retaining ring (4).

Note. When a specific item is to be replaced, follow the disassembly procedures only to the step that results in removal of the item to be replaced. For replacement, start with the step that results in replacement of the item.

g. Remove the four machine screws (19) (only one shown) to remove the mechanical counter.

Note. It is not necessary to perform procedures h and i below unless bevel gears (9) and (24) require replacement.

h. Loosen the socket-head screw (7) in the gear clamp (8) to remove the bevel gear (9).

i. If necessary, loosen the socket-head screw (22) in the gear clamp (23) to remove the bevel gear (24).

j. If necessary, loosen the socket-head screw (100) and square nut (98) of the gear clamp (99) to release the spur gear (93) and washer (92). Pull out the locked clutch gear assembly (21), washer (16), and pressed bevel gear (25).

k. Loosen the socket-head screw (11) to remove the bevel gear (10), gear clamp (15), and gear bushing (14).

l. If necessary, remove the front pressed coupling of the Oldham coupler (fig. 70).

m. Loosen the six binder-head screws (13) and (30) (only two shown), six split lockwashers (12) and (31) (only two shown), one special screw (28), and split lockwasher (29). Pull the front gear plate (32) forward to remove it.

n. If necessary, remove the retaining ring (121) and shim washers (122) and (123). Pull out the pinned stop assembly (94).

o. If necessary, remove the E-type retaining ring (85) and the pressed gear (86).

p. If necessary, remove the two machine screws (26) (only one shown) and the staked gear post (27).

q. Remove the pinned gear assembly (74), gear bushing (77), and shim washers (76) from the riveted front gear plate (109).

r. Remove the pinned gear assembly (95) and washers (96).

s. Remove the two binder-head screws (67), split lockwashers (68), and flat washers (69) (only one of each shown), to remove the detent spring (70).

t. Lift off the final differential gear assembly (39) from the differential shaft (73).

u. Pull out the pinned gear (110).

v. Remove the retaining ring (41) and the riveted gear (42).

w. Pull out the pinned spur gear (66) with the spur gear (79), gear clamp (71), socket-head screw (72), square nut (80), and gear bushing (78).

x. Loosen the socket-head screw (133) and square nut (131) of the gear clamp (132). Remove the loaded rack gear assembly (129).

y. Loosen the socket-head screw (137) and square nut (135) of the gear clamp (136). Pull out the gear assembly (134).

z. Loosen the socket-head screw (45) and square nut (43) of gear clamp (46). Pull out the soldered rack gear (44). Remove the retaining ring (47). Pull out the gear assembly, which consists of the soldered gear (48), spur gear (49), and two gear rack springs (50).

aa. Loosen the socket-head screw (51) and square nut (54) of gear clamp (52). Remove the soldered rack gear (53). Remove the retaining ring (58) and pull out the gear assembly (59).

ab. Remove the three machine screws (55) (only one shown). Lift off the 8- to 16-mc gear (63) with its leading gear (64) and two gear rack springs (65).

ac. Loosen the socket-head screw (140) and square nut (138) of gear clamp (139). Pull out the loaded rack gear assembly (141).

ad. Loosen the socket-head screw (116) and square nut (114) of gear clamp (115). If necessary, pull out the oscillator spur gear (117), flat washer (113), and oscillator dial hub (124).

Caution: Observe the positioning of the parts (fig. 68) of the switchgear assembly (87) before attempting to remove it. Be careful not to loose the ball bearing.

ae. If necessary, remove the retaining ring (88). Lift off the switch gear assembly (87) as one unit.

af. If necessary, remove the E-type retaining ring (102) and the locking gear (103).

ag. Loosen the two setscrews (175) and remove the retaining ring (174). Slide the antenna trimmer shaft (168) forward to remove the special washer (173), helical gear bushing (172), helical gear clamp (171), helical-driven gear (170), and shaft insulator (169).

ah. Loosen the socket-head screw (35) and the square nut (33) of the gear clamp (34). Pull out the idler gear (36) and gear bushing (37). Remove the retaining ring (125) and shaft sleeve (38) if necessary.

al. Loosen the socket-head screw (82) and the square nut (84) of the gear clamp (83). Slide the megacycle gear (90) and the soldered megacycle gear (91) off the rf stop assembly 1101). To separate items (90) and (91), remove the retaining ring (81) and the multiturn gear springs (89).

aj. Remove the retaining ring (106) and washers (105 and 104). Pull out the rf stop assembly (101).

100. Disassembly of Camshaft Assemblies
(fig. 88)

Caution: Mark each cam and camshaft for identification before removing it. If it is necessary to disassemble the camshaft assemblies, perform the procedures given in paragraph 99 and proceed as follows:

a. Slide the band switch shaft (fig. 44) to the rear to clear the riveted front gear plate (109).

b. Mark the pressed rear plate (177) at the points of the two soldered rf cams (182) and (184).

c,. Remove the two taper pins (183) and (185) and pull the soldered rf cams (184) and (182) off the camshafts (181) and (180).

d. Remove the three hexagonal-head screws (fig. 44).

e. Remove the three Phililps-head screws (not shown) that secure the pressed rear plate (177) to the rf amplifier subassembly (fig. 44).

f. Remove the flathead machine screw (127) and the machine screw (179) and split lockwasher (178) that secure the longpost (156).

g. Slide the pressed rear plate (177) to the rear to remove it.

h. Remove the two Phillips-head screws, two lockwashers, and two nuts (not shown) from the two cam plate brackets (118) (only one shown). The Phillips-head screws secure the rf gear train assembly to the rf amplifier subassembly.

i. Separate the rf amplifier subassembly from the rf gear train assembly.

j. Remove the six flathead machine screws (126) (only one shown) from the three short posts (152) (only one shown). Remove the pressed auxiliary cam plate (176).

Note: The camshafts can now be removed in any order. Go directly to the step that results in the removal of the camshaft or the cams to be replaced. Mark the pressed cam plate (149) at the points of the cams before removal.

k. Remove the taper pin (158) from the soldered rf cam (157). Slide the 0.5- to 1-mc camshaft (164) straight forward to remove it. Remove taper pin (57) to release soldered rf cam (56).

l. Remove taper pin (154) from the soldered rf cam (153). Slide the 1- to 2-mc camshaft (181) straight forward to remove it. Remove taper pin (147) to release soldered rf cam (146).

m. Remove taper pin (159) from soldered rf cam (162). Slide the 2- to 4-mc camshaft (163) straight forward to remove it. Remove taper pin (61) to release soldered rf cam (60).

n. The 4- to 8-me camshaft assembly and the 16- to 32-mc camshaft assembly are identical; each consists of camshafts (167), soldered rf cams (142) and (144) secured by taper pins (143) and (145), and soldered rf cams (155) and (165) secured by taper pins (166). Disassemble by removing the taper pin from each cam.

o. Remove the taper pin (161) from the soldered rf cam (160). Slide the 8- to 16mc camshaft (180) straight forward to remove it. Remove taper pin (75) to release the pressed gear assembly (62)

p. To remove the four long posts (148), remove the four Phillips-head screws (151) and four lockwashers (150), four Phillips-head screws (130) and four lockwashers (128). (Only one of each of the numbered items above is shown.) *Note:* The four long posts(148) fasten the pressed cam plate(149)to the riveted front gear plate (109).

101. Reassembly of Camshaft Assemblies
(fig. 88 and 68)

When a specific item is to be replaced, go directly to the procedure that results in replacement of the item and follow the reassembly procedures from that step onward.

a. To fasten the pressed camplate (149) to the riveted front gear plate (109), replace the four long posts (148), four machine screws (151), four lockwashers (150), four Phillips-head screws (130), and four lockwashers (128). (Only one of each of the numbered items above is shown).

Note: Figure 82 shows the normal positions of the cams viewed from the rear, with the two rear plates removed and the frequency indicator set at 07 +000.

b. Slide the 8- to 16-mc camshaft (180) through the holes marked A. Replace the pressed gear assembly (62) and the taper pin (75). Set the point of the cam to the cam

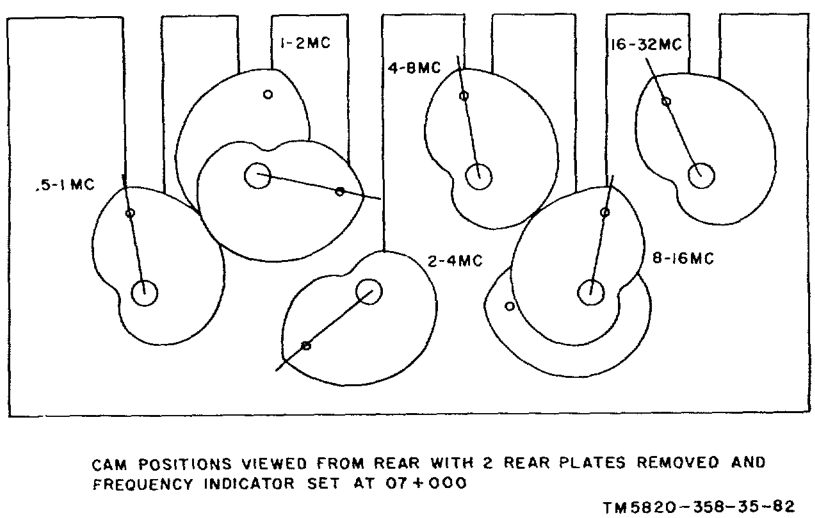


Figure 82. Rf gear train assembly cam positions viewed from rear, simplified mechanical diagram.

positioning mark on the riveted front gear plate. Set the point of the soldered rf cam (160) to the mark previously made on the pressed cam plate (149) and replace the taper pin (161).

c. Slide the 4- to 8-mec and the 8- to 16-mc camshafts (167) through the holes marked B and C. Replace the soldered rf cams (142) and (144) and secure them with the taper pins (143) and (145). Set the points of the cams to the cam positioning marks on the riveted front gear plate. Replace the soldered rf cams (155) and (165). Set the points of the cams to the marks previously made on the pressed cam plate (149). Replace the taper pins (166).

d. Slide the 2- to 4-mc camshaft (163) through the holes marked D. Replace the soldered rf cam (60) and taper pin (61). Set the point of the cam to the cam positioning mark. Replace the soldered rf cam (162) and taper pin (159) with the point of the cam set at the mark previously made on the pressed cam plate (149).

e. Slide the 1- to 2-mc camshaft (18i) through the holes marked E. Replace the soldered rf cam (146) and taper pin (147).
Set the point of the cam to the cam positioning mark. Replace the soldered rf cam (153) and taper pin (154) with the point of the cam set at the mark previously made on the pressed cam plate (149).

f. Slide the 0.5- to 1-mc camshaft (164) through the holes marked F. Replace the soldered rf cam (56) and taper pin (57). Set the point of the cam to the cam positioning mark. Replace the soldered rf cam (157) and taper pin (158) with the point of the cam set at the mark previously made on the pressed cam plate (149).

g. Secure the pressed auxiliary cam plate (176) with the three short posts (152) and six flathead machine screws (126) (only one of each shown).

h. Place the rf amplifier subassembly (fig. 44) in position to fasten it to the rf gear train assembly. Engage but do not tighten the two Phillips-head screws (not shown), two lockwashers (not shown), and two nuts (not shown) that fasten the two cam plate brackets (118) to the rf amplifier subassembly.

i. Slide the pressed rear plate (177) forward on the two camshafts (180) and (181) until it is against the rear of the rf amplifier subassembly. Engage but do not tighten the three Phillips-head screws (not shown) that fasten the pressed rear plate (177) to the rf amplifier subassembly.

j. Replace the long post (156)'but do not tighten the flathead machine screw (127) and the Phillips-head screw (179) and split lockwasher (178).

k. Replace the three hexagonal-head screws (fig. 44).

l. Slide the bandswitch shaft (fig. 44) forward until its retaining ring rests against the riveted front gear plate (109).

m. Tighten all the screws in the procedures given in h, i, j, and k above.

n. Replace the two soldered rf cams (184) and (182) on the two camshafts (181) and (180). Set the points of the cams at the marks previously made on the pressed rear plate (177). Replace the two taper pins (183) and (185).

102. Reassembly of Rf Gear Train Assembly (fig. 88)

a. Slide the rf stop assembly (101) into the ho l e marked G. Replace the two washers (104) and (105) and retaining ring (106). Slide the combination of the soldered megacycle gear (91), megacycle gear (90), two multiturn gear springs (89), gear clamp (83), socket-head screw (82), and square nut (84) on the rf stop assembly. Do not tighten the socket-head screw (82).

b. Push the shaft sleeve (38) into the hole marked H and replace the retaining ring (125), if both have been removed. Slide the gear bushing (37), idler gear (36), and gear clamp (34) on the shaft sleeve (38). Tighten the socket-head screw (35) and square nut (33).

c. Slide the antenna trimmer shaft (168) into the hole marked I. Replace the shaft insulator (169), helical-driven gear (170), helical gear clamp (171), and helical gear bushing (172). Push the antenna trimmer shaft (168) as far as it will go toward the rear. Replace the special washer (173) and retaining ring (174). Mesh the helical driven gear (170) and its mating gear. Tighten the two setscrews (175).

d. If necessary replace the locking gear (103) and E-type retaining ring (102) on the shaft marked K.

e. If necessary, slide the switch gear assembly (87) on the shaft marked J and replace the retaining ring (88). Position the assembly (fig. 68).

f. If necessary, slide the oscillator dial hub (124) into the hole marked L; then slide the oscillator spur gear (117), flatwasher (113), and gear clamp (115) on the hub (124). Replace but do not tighten the socket head screw (116) and square nut (114).

g. Slide the loaded rack gear assembly (141) on the 16- to 32-me shaft (167). Load the assembly (141) two teeth before meshing it with the pressed gear assembly (62).

Tighten the socket-head screw (140) and square nut (138) of the gear clamp (139).

h2. Place the 8- to 16-me gear (63) with its loading gear (64) on the pressed gear assembly (62). Replace the two gear rack springs (65) and the three machine screws (55) (only one shown).

i. Slide the gear assembly (59) on the 2 to 4-mc camshaft (163) and replace the retaining ring (58). Replace the gear clamp (52), socket-head screw (51), square nut (54), and soldered rack gear (53). Tighten the socket-head screw (51).

j. Slide the gear assembly consisting of soldered gear (48), spur gear (49), and two gear rack springs (50) on the 0.5- to 1-me camshaft (164). Replace the retaining ring (47), gear clamp (46), socket-head screw (45), square nut (43), and soldered rack gear (44). Tighten the socket-head screw (45).

k. Slide the gear assembly (134) with gear clamp (136), socket-head screw (137), and square nut (135) on the 4- to 8-mec camshaft (one of two) (167). Load the gear assembly (134) two teeth before meshing it with the soldered rack gear (53).

l. Slide the loaded rack gear assembly (129) on the 1- to 2-mec camshaft (181). Load the loaded rack gear (129) two teeth before meshing it with the soldered rack gear (44). Tighten the socket-head screw (133) and square nut (131) of the gear clamp (132).

m. Slide the shaft of the assembly consisting of the pinned spur gear (66), gear clamp (71), socket-head screw (72), square nut (80), spur gear (79), and gear bushing (78) into the hole marked M.

n. Replace the riveted gear (42) and retaining ring (41) on the 8- to 16-mec camshaft (180).

o. Slide the shaft of the pinned gear (110) into the hole marked N.

p. Slide the differential gear assembly (39) on the differential shaft (73). Load the loaded rack gear assembly (59) two teeth before meshing the final differential gear assembly (39) with it. Load the combination of the megacycle gear (90) and soldered megacycle gear (91), which was assembled in a above. Slide the assembly forward to mesh it with the final differential gear assembly (39). Tighten the socket-head screw (82).

q. Secure the detent spring (70) with the two binder-head screws (67), two flat washers (69), and two split lockwashers (68) (only one of each shown).

r. Slide the shaft of the pinned gear assembly (95) with two washers (96) into the hole marked O.

s. Slide the shaft of the pinned gear assembly (74) with gear bushing (77) and shim washers (76) into the hole marked P.

t. If necessary, slide the staked gear post (27) into the hole marked U, and replace the two machine screws (26) (only one shown).

u. If necessary, replace the pressed gear (86) and E-type retaining ring (85).

v. Slide (if necessary) the shaft of the pinned stop assembly (94) into the hole marked Q. Replace the shim washers (123) and (122) and retaining ring (121).

w. Slide the front gear plate (32) into place. Replace the six binder-headscrews (13) and (30) (only two shown) and six split lockwashers (12) and (31) (only two shown). Secure the special screw (28) and split lockwasher (29) in the hole marked V.

x. Replace the front pressed coupling of the Oldham coupler (fig. 70).

y. Slide the gear bushing (14), gear

clamp (15), and bevel gear (10) onto the shaft of the pinned gear (110). Tighten the socket-head screw (11).

z. Slide the shaft of the locked clutch gear assembly (21), with the washer (16) in place, through the hole marked R. Replace the washer (92), spur gear (93), and gear clamp (99) with socket-head screw (100) and square nut (98). Load the loaded rack gear (part of (21)) two teeth, mesh it with the pressed bevel gear (25), and slide the combination into place. Slide the pressed gear assembly consisting of (92), (93), (99), (98), and (100) forward on the shaft of the locked clutch gear assembly (21) until the spur gear (93) is against the front gear plate (32) and is meshed with the pressed gear (86).

aa. If necessary, replace the gear clamp (23) with socket-head screw (22) and bevel gear (24) on the mechanical counter (17) shaft marked T. Tighten the socket-head screw (22).

ab. Replace (if necessary) the gear clamp (8) with socket-heed screw (7) and bevel gear (9) on the remaining mechanical counter (17) shaft.

ac. Set the mechanical counter (17) to 07 +000. Place the mechanical counter (17) in position and secure the four machine screws (19) (only one shown).

ad. Replace (if necessary) the two rack gear springs (3) (only one shown) and retaining ring (4). Slide the gear clamp (6) with socket-head' screw (20) and square nut (5) on the hub of the spur gear (2). Load the spur gear (2) two teeth and slide it on the pinned stop assembly (94) until the spur gear (2) meshes with the front gear of the locked clutch gear assembly (21).

ae. Replace the crystal-oscillator sul)chassis (para 60c) and the rf sul)chassis (para 59c).

af. Check the mechanical and electrical synchronization (para 70).

ag. Replace the 8 slug racks and l(; tension springs (para 63a(2)).

ah. Replace the front panel (para 58c).

103. Rf Gear Train Assembly Parts Legend (fig 88)

Index No.	Reference symbol	Description
1	A216	Riveted locking plate
2	O323	Spur gear
3	O322	Rack gear springs
4	H213	7/16-inch retaining ring
5	H219	4-40 square nut
6	O207	Gear clamp
7	H217	3/56 by 1/4-inch socket-head screw
8	H231	Gear clamp
9	O202	Bevel gear
10	O213	Bevel gear
11	H217	4-40 by 9/16-inch socket-head screw
12	H201	No. 8 split lockwashers
13	H230	8-32 by 3/8-inch binder-head screws
14	O221	Gear bushing
15	H231	Gear clamp
16	H251	Washers
17	M201	Mechanical counter
18	H202	No. 4 split lockwashers
19	H227	4-40 by 5/16-inch machine screws
20	H218	4-40 by 9/16-inch socket-head screw
21	O295	Locked clutch gear assembly
22	H217	3/56 by 1/4-inch socket-head screw
23	H231	Gear clamp
24	O212	Bevel gear
25	O296	Pressed bevel gear
26	H228	6-32 by 3/16-inch machine screws

Index No.	Reference symbol	Description
27	O252	Staked gear post
28	H240	Special screw
29	H212	No. 5 split lockwasher
30	H230	8-32 by 3/8-inch binder-head screws
31	H201	No. 8 split lockwashers
32	A201	Front gear plate
33	H219	4-40 square nut
34	H233	0.312-inch hole gear clamp
35	H215	4-40 by 1/2-inch socket-head screw
36	O204	Idler gear
37	O242	Gear bushing
38	O215	Shaft sleeve
39	O219	Final differential gear assembly
40	H236	Gear panel spacing posts
41	H224	1/4-inch retaining ring
42	O205	No. 8 riveted gear
43	H219	4-40 square nut
44	O201	Soldered rack gear
45	H218	4-40 by 9/16-inch socket-head screw
46	O208	Gear clamp
47	H234	Retaining ring
48	O392	Soldered gear
49	O254	Spur gear
50	O325	Gear rack springs
51	H218	4-40 by 9/16-inch socket-head screw
52	O209	Gear clamp
53	P363	Soldered rack gear
54	H219	4-40 square nut
55	H241	4-40 by 1/4-inch machine screws
56	O311	Soldered rf cam
57	O311	No. 6/0 taper pin
58	H234	Retaining ring
59 c		No. 2 gear assembly
60	O313	Soldered rf cam
61	O313	No. 6/0 taper pin
62	O315	Pressed gear assembly
63	O328	8- to 16-mc gear
64	O324	8- to 16-mc loading gear
65	O273	Gear rack springs
66	O390	Pinned spur gear
67	H216	6-32 by 1/4-inch binder-head screws
68	H203	No. 6 split lockwashers
69	H213	No. 6 flat washers
70	O244	Detent spring
71	H233	0.312-inch hole gear clamp
72	H215	4-40 by 1/2-inch socket-head screw
73	O206	Differential shaft
74	O261	Pinned gear assembly
75	O315	Taper pin
76	H254	Washers
77	O222.	Gear bushing
78	O223	Gear bushing
79	O243	Spur gear
80	H219	4-40 square nut
81	H213	7/16-inch retaining ring
82	H218	4-40 by 9/16-inch socket-head screw
83	O211	Gear clamp
84	H219	4-40 square nut
85	H222	1/4-inch E-type retaining ring

Index No.	Reference symbol	Description
86	O253	Pressed gear
87	O307	Switch gear assembly
88	H237	Retaining ring
89	O319	Multiturn gear springs
90	O218	Megacycle gear
91	O321	Soldered megacycle gear
92	H251	Washers
93	O245	Spur gear
94	O316	Pinned stop assembly
95	O246	Pinned gear assembly
96	H254	Washers
97	H235	Panel spacing posts
98	H219	4-40 square nut
99	H233	0.312-inch hole gear clamp
100	H215	4-40 by ½-inch socket-head screw
101	O317	Rf stop assembly
102	H221	E-type 1/8-inch retaining ring
103	O203	Locking gear
104	H251	Washers
105	H253	Washers
106	H234	Retaining ring
107	H226	8-32 by 5/16-inch flathead machine screw
108	H226	8-32 by 5/16-inch flathead machine screw
109	A202	Riveted front gear plate
110	O283	Pinned gear
111	H201	No. 8 split lockwashers
112	H230	8-32 by 3/8-inch machine screws
113	H214	5/16-inch flat washer
114	H219	4-40 square nut
115	O210	Gear clamp
116	H218	4-40 by 9/16-inch socket-head screw
117	O241	Oscillator spur gear
118	A206	Cam plate brackets
119	H255	6-32 by 7/16-inch machine screws
120	H203	No. 6 split lockwashers
121	H224	¼-inch retaining ring
122	H251	Shim washer
123	H253	Shim washer
124	O240	Oscillator dial hub
125	H224	¼-inch retaining ring
126	H225	6-32 by 3/8-inch flathead machine screws
127	H225	6-32 by 3/8-inch flathead machine screw
128	H203	No. 6 split lockwashers
129 a		Loaded rack gear assembly
130	H229	6-32 by 3/8-inch Phillips-head screws
131	H219	4-40 square nut
132	H233	0.312-inch hole gear clamp
133	H215	4-40 by ½-inch socket-head screw
134 b		Gear assembly No. 4
135	H219	4-40 square nut
136	H233	0.312-inch hole gear clamp
137	H215	4-40 by ½-inch socket-head screw
138	H219	4-40 square nut
139	H233	0.312-inch hole gear clamp
140	H215	4-40 by ½-inch socket-head screw
141 a		Loaded rack gear assembly
142	O314	Soldered rf cam
143	O314	No. 6/0 taper pin

Index No.	Reference symbol	Description
144	O314	Soldered rf cam
145	O314	No. 6/0 taper pin
146	O312	Soldered rf cam
147	O312	No. 6/0 taper pin
148	H244	Posts
149	A209	Pressed cam plate
150	H203	No. 6 split lockwashers
151	H229	6-32 by 3/8-inch machine screws
152	H242	Short posts
153	O312	1- to 2-mc soldered rf cam
154	O312	No. 6/0 taper pin
155	O314	Soldered rf cam
156	H243	Long post
157	O311	Soldered rf cam
158	O311	No. 6 taper pin
159	O313	No. 6/0 taper pin
160	O315	Soldered rf cam
161	O315	Taper pin
162	O313	Soldered rf cam
163	O313	Camshaft
164	O311	Camshaft
165	O314	Soldered rf cam
166	O314	No. 6/0 taper pin
167	O314	Camshafts
168	O236	Trimmer shaft
169	E227	Vfo shaft insulator
170	O318	Helical-driven gear
171	H245	Helical gear clamp
172	O256	Helical gear bushing
173	H232	Special washer
174	H223	3/16-inch retaining ring
175	H220	8-32 by 1/8-inch setscrews
176	O306	Pressed auxiliary cam plate
177	A208	Pressed rear plate
178	H203	No. 6 split lockwashers
179	H229	6-32 by 3/8-inch machine screw
180	O315	Camshaft
181	O312	1- to 2-mc camshaft
182	O312	Soldered rf cam
183	O312	No. 6/0 taper pin
184	O315	Soldered rf cam
185	O315	Taper pin

[a] Index No. 129 and 141 consist of H234, O262, O254, and O247.
[b] Index No. 134 consists of O253, O273, O274, and O324.
[c] Index No. 59 consists of O270, O27:, O259, and H234.

Note: Parts O311 through O315 make up the entire camshaft assembly.

CHAPTER 5

DEPOT INSPECTION PROCEDURES

Section I. PREPARATION

104. Purpose of Depot Inspection Procedures

The tests outlined in this section are designed to measure the performance capability of a repaired R-390A/URR. Equipment that meets the minimum standards in the tests will furnish satisfactory operation, equivalent to that of new equipment.

105. Test Equipment and Additional Equipment Required

a. Test Equipment. Test equipment of the type listed below or equivalent, is required for depot testing of Radio Receiver R-390/URR.

Test equipment	Stock No	Quantity
Spectrum Analyzer TS-723/U	6625-668-9418	1
Frequency Meter AN/USM-26	6625-692-6553	1
Electronic Multimeter TS-505/U	6625-243-5381	1
R. F. Signal Generator Set AN/URM-25	6625-309-5381	1
Voltmeter, Meter ME-30/U	6625-669-0742	1
Signal Generator AN/USM-44	6625-669-4031	1

b. Additional Equipment Required.

Additional equipment	Stock No.	Quantity
Headset, 600-ohm	5965-164-7259	1
Resistor, composition 60-ohm, 1W±5%	5905-279-2980	1
Resistor, composition 62-ohm, ½W ±5%	5905-101-9429	3
Resistor, composition 600-ohm, 1W±5%	5905-259-2809	2
Resistor, composition 68-ohm, ½W ±5%	5905-195-5571	1
Resistor, composition 33-ohm, ½W ±5%	5905-101-9252	1
Variable Transformer CN-16/U	5950-235-2086	1
Power Supply PP-621/URR	Part of Receiver	1
Voltmeter 0-150 vac, 60 cps, ±1.25%	3F7385	1
Electronic Equipment Maintenance Kit MK-288/URM	6625-557-5716	1

106. Test Setup

All tests will be performed under the conditions listed below. Testing will be simplified if connections and panel-control settings are made initially and changed only as required for the individual tests. For conducting the tests in an electrically noisy area, a screened room is mandatory.

Line voltage and frequency .... 115 volts ac +5 percent at 60 cycles
Warm-up period.......................... 3 hours
Standard modulation.................... 30 percent am. at 400 cycles
Audio load impedance .... 600 ohms
For tests at 10 me and higher, use Signal Generator AN/USM-44 (Hewlett Packard, Model 608D) instead of RF Signal Generator AN/URM-25D.
Dummy antenna for balanced input shall be DA-121/U, part of MK-288/URM.
Receiver chassis shall be grounded during all testing procedures.
Front-panel controls as follows:

Control	Position	Control	Position
FUNCTION	As required		
ANT TRIM	Adjust for maximum output	BANDWIDTH	8
	LINE METER	OFF	OFF
BFO	OFF	LINE GAIN	0
DIAL LOCK	Unlocked	AGC	MED
ZERO ADJ	Disengaged	LIMITER	OFF
LOCAL GAIN	As required	AUDIO RESPONSE	WIDE
RF GAIN	10 (maximum)	BFO PITCH	0
OVENS (back panel)	OFF	BREAK IN	OFF

Section II. TESTS

107. Am. Sensitivity Test

Set the front-panel controls (para 106). Turn the FUNCTION switch to MGC. Make the am. sensitivity test at both ends and in the center of each band. Use a 30-percent modulated 400-cps signal.

a. Connect a signal generator to the BALANCED antenna jack.

b. Connect the ME-30/U in parallel with the 600-ohm, 1-watt resistor between LOCAL AUDIO terminals 6 and 7.

c. Tune the signal generator, and the receiver to the same frequency.

d. Adjust the signal generator attenuator for the following output.

Band (mc)	Signal generator (microvolts)
0.5-16	4
16-32	5

e. Adjust the LOCAL GAIN control to obtain an ME-30/U reading of 2.45 volts.

f. Turn the modulation off. The ME-30/U indication must not be more than 0.77 volts.

108. Cw Sensitivity Test

Set the front-panel controls (para 106). Turn the FUNCTION switch to MGC. Make the cw sensitivity test at any frequency.

a. Connect the signal generator to the BALANCED antenna jack.

b. Connect the ME-30/U in parallel with the 600-ohm, 1-watt resistor between
LOCAL AUDIO terminals 6 and 7.

c. Tune the signal generator and the receiver to the same frequency.

d. Adjust the signal generator attenuator for the following output.

Band (mc)	Signal generator (microvolts)
0.5-16	1
16.32	1

e. Turn the BFO switch to ON.

f. Adjust the BFO PITCH control for approximately a 1,000-cycle tone.

g. Adjust the LOCAL GAIN control for an ME-30/U indication of 2.45 volts.

h. Turn the BFO switch to OFF. The ME-30/U indication must be less than 0.77 volts.

109. Overall Selectivity Test

Set the front panel controls (para 106). Turn the FUNCTION switch to MGC.

a. Connect the signal generator to the BALANCED antenna jack.

b. Connect the TS-505(*)/U between DIODE LOAD terminal 14 and GND terminal 16.

c. Tune the receiver to some frequency that ends in an even 10 kc between 0.5 and 32 me. Tune the signal generator to the same frequency. Adjust the signal generator attenuator for a 15-microvolt (uv) output.

d. Turn the BFO PITCH control to 0.

e. Turn the BFO switch to ON.

f. Turn the BANDWIDTH switch to 1.

g. Zero-beat the signal generator with the receiver.

h. Turn the BFO switch to OFF.

i. Adjust the RF GAIN control to obtain a -5-volt indication on the TS-505(*)/U.

j. Detune the signal generator until the TS-505(*)/U indication is the same as in the *Specified standard* column. The deviation must not be more than that indicated in the *Deviation* column.

BANDWIDTH switch	Specific standard (volts)	Deviation not more than (kc)
1	2.5	1.5
1	0.5	3.0
1	0.05	5.0
16	2.5	16.0
16	0.5	19.5
16	.05	24.0

110. Overall Gain Test, Depot

Set the front-panel controls (para 106). Turn the FUNCTION switch to MGC. Turn the DIAL LOCK and ZERO ADJ controls fully counterclockwise.

a. Connect the signal generator to the BALANCED antenna jack.

b. Set the GAIN ADJ potentiometer R562 on the if subchassis (para 73).

c. Connect the TS-505(*)/U across DIODE LOAD terminal 14 and GND terminal 16 without removing the jumper wire from terminal 15.

d. Tune the signal generator and the receiver to 500 kc. Turn the BFO switch to ON, and zero-beat the signal generator with the receiver.

e. Turn the BFO switch to OFF, and adjust the ANT TRIM control for a maximum TS-505(*)/U voltage indication.

f. Adjust the signal generator attenuator for a TS-505(*)/U indication of -7-volts, and record the setting.

g. The signal generator output must indicate between 1 and 4 microvolts.

h. Perform procedures d through g above at both ends and in the center of each of the following six rf coil ranges:

Coil ranges (mc)
0.5—1
1—2
2—4
4—8
8—16
16—32

111. Maximum Audio Output Test

Set the front panel controls (para 106). Turn the FUNCTION switch to AGC.

a. Connect the signal generator to the BALANCED antenna jack.

b. Connect the TS-505(*)/U across DIODE LOAD terminal 14 and GND terminal 16.

c. Turn the BFO switch to ON.

d. Tune the receiver to 1.5 mc.

e. Zero-beat the signal generator with the receiver.

f. Turn the BFO switch to OFF.

g. Adjust the ANT TRIM control for maximum TS-505(*)/U voltage indication.

h. Connect the ME-30/U in parallel with a 600-ohm, 1-watt resistor between chassis ground and the test points in the chart below.

i. With a 10 uv 400-cps modulated 30-percent input, the required output is:

Test point	Specific (not less than)
LOCAL AUDIO	17.3 vac
LINE AUDIO	2.45 vac
PHONES	0.78 vac

112. Audio Harmonic Distortion Test

a. Connect the signal generator to the BALANCED antenna jack. Adjust the signal generator for a 1,000 uv 30-percent modulated 400-cps signal.

b. Turn the FUNCTION switch to AGC.

c. Tune the signal generator and the receiver to 1.5 mc.

d. Connect the ME-30/U and the TS-723/U in parallel with a 600-ohm resistor to the terminals in f and g below.

e. Adjust the LOCAL GAIN and LINE GAIN controls to produce the test audio voltage levels used in f and g below.

f. With 17.3 volts between LOCAL AUDIO terminals 6 and 7, the distortion, as indicated by the TS-723/U must not exceed 10 percent.

g. With 2.45 volts between LINE AUDIO terminals 10 and 13, the distortion as indicated by the TS-723/U must not exceed 6 percent.

113. Automatic Gain Control Test

Set the front panel controls (para 106). Turn the FUNCTION switch to AGC.

a. Connect the signal generator to the BALANCED antenna jack. Connect the ME-30/U to LOCAL AUDIO terminals 6 and 7.

b. Tune the signal generator to successive receiver settings of 1.5, 3.0, 6.0, 12.0 and 24.0 mc, modulating the output 30 percent at 400 cps.

c. With a -5 uv output from the signal generator, tuned to the frequencies in above, adjust the LOCAL GAIN control for 1.7 volts across the LOCAL AUDIO terminals.

d. With signal generator inputs to the receiver of 1,000 uv and 100,000 uv, note the proportionate increases in audio output.

Signal generator output	Specific (not more than)
1,000 uv	3.0 ac volts
100,000 uv	5.4 ac volts

e. Adjust the signal generator output for a reading of 20 on the CARRIER LEVEL meter.

f. Increase the output of the signal generator in 20-db steps and note that the CARRIER LEVEL meter indications increase in steps of 20 ±6.

g. Decrease the signal generator output 20 db below the setting in procedure e above, and note that the reading on the CARRIER LEVEL meter indication will drop between 6 and 0.

114. Frequency Range Test

The frequency range of each band must not be less than the following:

Band	Frequency (mc)
0	0.5—1.0
1	1.0—2.0
2	2.0—3.0
3	3.0—4.0
4	4.0—5.0
5	5.0—6.0
6	6.0—7.0
7	7.0—8.0
8	8.0—9.0
9	9.0—10.0
10	10.0—11.0
11	11.0—12.0
12	12.0—13.0
13	13.0—14.0
14	14.0—15.0
15	15.0—16.0
16	16.0—17.0
17	17.0—18.0
18	18.0—19.0
19	19.0—20.0
20	20.0—21.0
21	21.0—22.0
22	22.0—23.0
23	23.0—24.0
24	24.0—25.0
25	25.0—26.0
26	26.0—27.0
27	27.0—28.0
28	28.0—29.0
29	29.0—30.0
30	30.0—31.0
31	31.0—32.0

115. Dial Calibration and Resettability Tests

a. *Resettability*. It must be possible to tune the receiver visually to any frequency to an accuracy within 300 cps when the indicating counter has been adjusted at the nearest 100-kc calibration point. In each case, minimize backlash error by tuning to the test frequency from the low-frequency side. When the indicating counter has been adjusted at the low end of the range, error at the high end of the range must be within -1,500 to +200 cps.

b. *Dial Calibration (Kc).*

(1) Connect the signal generator and the AN/USM-26 to the BALANCED antenna jack.

(2) Turn the MEGACYCLE CHANGE control for 01 on the frequency indicator.

(3) Turn the KILOCYCLE CHANGE control to the 50-kc points between each of the 100-kc calibration points throughout the range of the KILOCYCLE CHANGE control.

(4) At each of the frequencies listed in paragraph 114, zero-beat the signal generator with the receiver.

(5) The frequency as indicated on the AN/USM-26 must be within ±300 cps of the receiver frequency indicator.

c. *Dial Calibration (Mc).*

(1) Connect the AN/USM-26 to the LOCAL AUDIO terminals 6 and 7.

(2) Calibrate the receiver at 500 kc.

(3) Without further adjustment of the BFO PITCH and KILOCYCLE CHANGE controls, turn the MEGACYCLE CHANGE control through each of its 32 positions.

(4) At each position in procedure (3) above, the frequency as indicated on the AN/USM-26 must be less than 4 kc between any tow adjacent MEGACYCLE CHANGE positions.

116. BFO test

Set the front-panel controls (para 106). Turn the FUNCTION switch to MGC.

a. Connect the signal generator to the BALANCE antenna jack.

b. Connect the AN/USM-26 to the IF OUTPUT jack.

c. Connect the headphones to the PHONES jack.

d. Turn the BFO PITCH control to 0. Zero-beat the signal generator with the receiver. The frequency as indicated on the AN/USM-26 must be 455 kc.

e. Connect the AN/USM-26 to LOCAL AUDIO terminals 6 and 7.

f. Turn the BFO PITCH control to +3 and -3. The audio output frequency as indicated by the AN/USM-26 must be 3 kc ±600 cps in both cases.

117. Calibration Oscillator Test

This adjustment requires the use of an extremely accurate frequency standard for determining the reference frequency. Station WWV at the Bureau of Standards, Washington, D. C., should be used as the frequency standard if it is at all possible to receive signals from this station. Station WWV operates on 2.5 mc, 5 mc, 10 mc, 15 mc, and 20 me. Use the highest frequency signal that can be reliably received by the receiver.

a. Tune in the highest frequency signal from WWV that can be received reliably.

b. Turn the BANDWIDTH switch to .1.

c. Tune the receiver to the exact resonance by adjusting the KILOCYCLE CHANGE and ANT TRIM controls for a maximum CARRIER LEVEL meter indication.

d. Turn the LINE METER switch to -10 and adjust the LINE GAIN control for a half-scale LINE LEVEL meter indication.

e. Turn the BFO switch to ON and adjust the BFO PITCH control to exact zero beat with WWV (during non-tone periods). Zero beat is attained when the LINE LEVEL meter indication drops to zero and fluctuates at a slow rate.

f. Turn the FUNCTION switch to CAL.

g. If necessary, adjust the CAL. ADJ (on the receiver rear panel) for zero beat, through the rear panel access hole (a minimum LINE LEVEL meter indication).

118. Line Level Meter Test

Set the front-panel controls (para 106). Turn the FUNCTION switch to AGC.

a. Connect the AN/URM-25 to the BALANCE antenna jack.

b. Tune the AN/URM-25 and the receiver to 1,500 kc.

c. Adjust the AN/URM-25 for a 1,000 uv signal, modulated 30 percent at 1,000 cps.

d. Connect the ME-30/U in parallel with a 600-ohm, 1-watt resistor between LINE AUDIO terminals 10 and 13.

e. Turn the LINE METER switch to 0.

f. Adjust the LINE GAIN control for a LINE LEVEL meter indication at the VU mark.

g. The audio output voltage as indicated on the ME-30/U must be 0.77 volts ±5%.

119. If. Output Test, Depot

Set the front-panel controls (para 106). Turn the FUNCTION switch to MGC.

a. Connect the signal generator to the BALANCE antenna jack.

b. Tune the signal generator and the receiver to 1.5 mc.

c. Turn the BFO switch to ON.

d. Set the signal generator for a 3-microvolts output.

e. Connect the headphones to the PHONES jack.

f. Zero-beat the signal with the receiver.

g. Turn the BFO switch to OFF.

h. Connect the TS-505(*)/U between DlODE LOAD terminal 14 and GND terminal 16.

i. Adjust the ANT TRIM control for maximum voltage indication on the TS-505(*)/U.

j. Connect the ME-30/U in parallel with a 60-ohm, 1-watt resistor between J116 IF OUTPUT 50 OHM jack and chassis ground.

k. Adjust the RF GAIN control to obtain a 20-millivolt indication on the ME-30/A.

l. The if output voltage as indicated by the ME-30/A must be as follows:

Input (microvolts)	Output (millivolts)
6	40±10%
15	100±10%
30	200±10%

120. Limiter-Clipping-Level Test

Set the front-panel controls (para 106). Turn the FUNCTION switch to AGC.

a. Connect the AN/URM-25 to the BALANCED antenna jack.

b. Tune the AN/URM-25 and the receiver to 1.500 kc.

c. Adjust the AN/URM-25 output to 1,000 uv modulated 50 percent at 400 cps.

d. Adjust the LINE GAIN control for a LINE LEVEL indication at the VU mark.

e. Slowly turn the LIMITER control from OFF to 10.

f. As the LIMITER control is advanced from the OFF position to 10, the LINE LEVEL meter indication may drop 1 db, return to the VU mark, then smoothly and gradually move to the left.

121. Antenna Relay Grounding Test

Set the front-panel controls (para 106). Turn the FUNCTION switch to AGC, and the BFO switch to ON.

a. Connect the AN/USM-44 to the BALANCED antenna jack.

b. Zero-beat the AN/USM-44 with the receiver at 30.05 me.

c. Turn the BFO switch to OFF.

d. Connect the TS-505(*)/U to DIODE LOAD terminal 14 and GND terminal 16.

e. Adjust the ANT TRIM control for a maximum TS-505(*)/U indication.

f. Adjust the AN/USM-44 output voltage for a TS-505(*)/U indication of -5 volts. Note the AN/USM-44 output voltage.

g. Turn the FUNCTION switch to CAL.

h. Increase the AN/USM-44 output voltage until the TS-505/U indication is again -5 volts. Note the AN/USM-44 output voltage.

i. The AN/USM-44 output voltage noted in *h* above must be at least 300 times the output voltage noted in *f* above.

122. Antenna Balance Ration Test

Set the front-panel controls (para 106). Turn the FUNCTION switch. to MGC.

a. Set the receiver frequency dial to 00 +000.

b. Connect the output of the signal generator between chassis ground and the junction of two 62-ohm resistors. Connect the free end of each resistor to each BALANCE antenna terminal.

c. Tune the signal generator to the receiver frequency.

d. Connect the TS-505(*)/U between DIODE LOAD terminal 14 and GND terminal 16.

e. Adjust the signal generator output for a -7 volt, TS-505(*)/U indication. Note the output of the signal generator.

f. Disconnect the two 62-ohm resistors, and connect the signal generator directly to the BALANCE antenna jack. Repeat the procedure given in *e* above and note the signal generator output.

g. Repeat the procedures given in *e* and *f* above for the following frequency indicator settings. The voltages noted in *e* above must exceed those noted in *f* above by at least the following ratio:

Dial reading	Ratio
00 + 000	178
01 + 000	100
03 + 000	100
07 + 000	56
15 + 000	31
31 + 000	10

123. Operational Checks

a. The meters must operate satisfactorily.

b. All controls must operate smoothly.

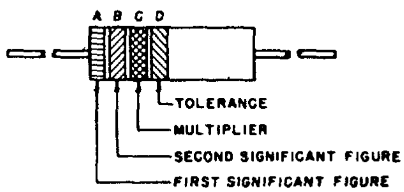
c. The quality of the signals must be excellent.

d. The frequency indicator must function properly.

e. The vibration effects must be negligible.

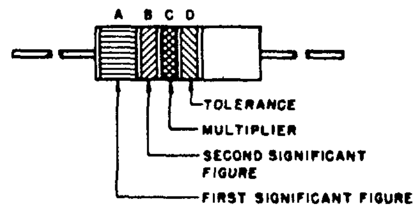
COLOR CODE MARKING FOR MILITARY STANDARD RESISTORS

COMPOSITION-TYPE RESISTORS



BAND A—Equal Width Band Signifies Composition-Type

WIREWOUND-TYPE RESISTORS



BAND A—Double Width Signifies Wire-wound Resistor

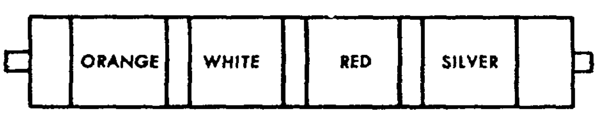
COLOR CODE TABLE

BAND A		BAND B		BAND C		BAND D*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1		
BROWN	1	BROWN	1	BROWN	10		
RED	2	RED	2	RED	100		
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000	SILVER	± 10
GREEN	5	GREEN	5	GREEN	100,000	GOLD	± 5
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	SILVER	0.01		
WHITE	9	WHITE	9	GOLD	0.1		

EXAMPLES OF COLOR CODING

BAND

A B C D*



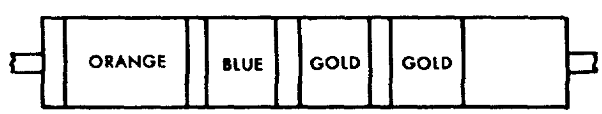
3 9 X100 ± 10%

NOMINAL RESISTANCE 3,900 Ohms

RESISTANCE TOLERANCE ± 10 percent

BAND

A B C D*



3 6 X0.1 ± 5%

NOMINAL RESISTANCE 3.6 Ohms

RESISTANCE TOLERANCE ± 5 percent

STD-R2

If Band D is omitted, the resistor tolerance is ± 20%, and the resistor is not Mil-Std.

Figure 83. Resistor color codes.

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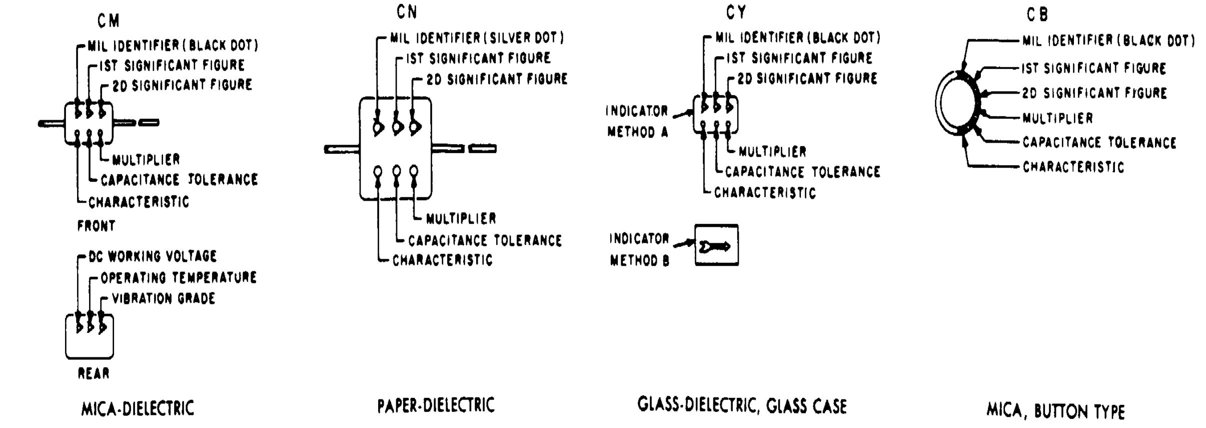
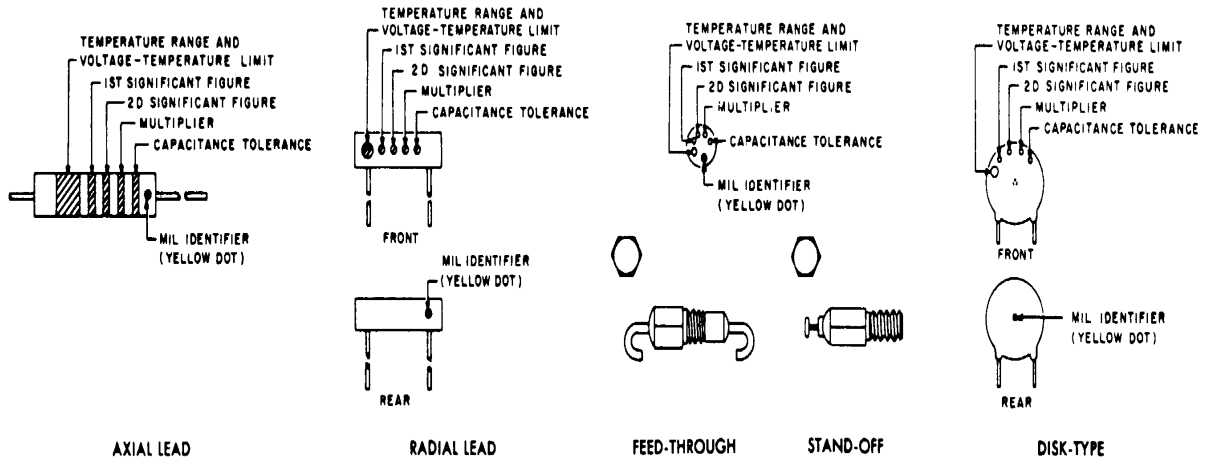
COLOR CODE MARKING FOR MILITARY STANDARD CAPACITORS

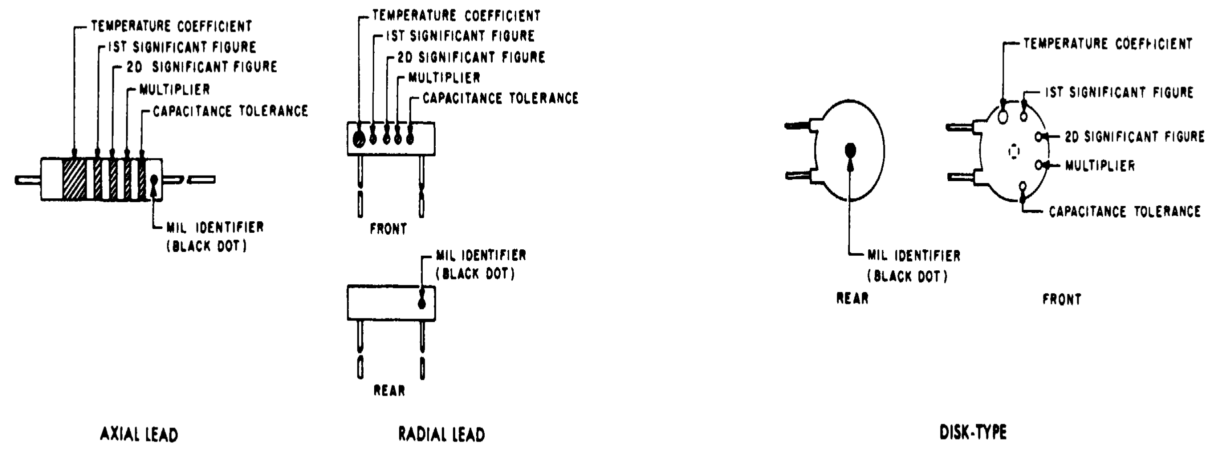
GROUP I Capacitors, Fixed, Various-Dielectrics, Styles CM, CN, CY, and CB



GROUP II Capacitors, Fixed Ceramic-Dielectric (General Purpose) Style CK



GROUP III Capacitors, Fixed, Ceramic-Dieletric (Temperature Compensating) Style CC



COLOR CODE TABLES

TABLE I – For use with Group I, Styles CM, CN, CY and CB

COLOR	MIL ID	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE				CHARACTERISTIC[2]				DC WORKING VOLTAGE	OPERATING TEMP. RANGE	VIBRATION GRADE
					CM	CN	CY	CB	CM	CN	CY	CB	CM	CM	CM
BLACK	CM, CY CB	0	0	1			± 20%	± 20%		A				−55° to +70°C	10–55 cps
BROWN		1	1	10					B	E		B			
RED		2	2	100	± 2%		± 2%	± 2%	C		C			−55° to +85°C	
ORANGE		3	3	1,000		± 30%			D			D	300		
YELLOW		4	4	10,000					E					−55° to +125°C	10–2,000 cps
GREEN		5	5		± 5%				F				500		
BLUE		6	6											−55° to +150°C	
PURPLE (VIOLET)		7	7												
GREY		8	8												
WHITE		9	9												
GOLD				0.1			± 5%	± 5%							
SILVER	CN				± 10%	± 10%	± 10%	± 10%							

TABLE II – For use with Group II, General Purpose, Style CK

COLOR	TEMP. RANGE AND VOLTAGE – TEMP. LIMITS[3]	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE	MIL ID
BLACK		0	0	1	± 20%	
BROWN	AW	1	1	10	± 10%	
RED	AX	2	2	100		
ORANGE	BX	3	3	1,000		
YELLOW	AV	4	4	10,000		CK
GREEN	CZ	5	5			
BLUE	BV	6	6			
PURPLE (VIOLET)		7	7			
GREY		8	8			
WHITE		9	9			
GOLD						
SILVER						

TABLE III – For use with Group III, Temperature Compensating, Style CC

COLOR	TEMPERATURE COEFFICIENT[4]	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE		MIL ID
					Capacitances over 10uuf	Capacitances 10uuf or less	
BLACK	0	0	0	1		± 2.0uuf	CC
BROWN	−30	1	1	10	± 1%		
RED	−80	2	2	100	± 2%	± 0.25uuf	
ORANGE	−150	3	3	1,000			
YELLOW	−220	4	4				
GREEN	−330	5	5		± 5%	± 0.5uuf	
BLUE	−470	6	6				
PURPLE (VIOLET)	−750	7	7				
GREY		8	8	0.01			
WHITE		9	9	0.1	± 10%		
GOLD	+100					± 1.0uuf	
SILVER							

1. The multiplier is the number by which the two significant (SIG) figures are multiplied to obtain the capacitance in uuf.
2. Letters indicate the Characteristics designated in applicable specifications: MIL–C–5, MIL–C–91, MIL–C–11272, and MIL–C–10950 respectively.
3. Letters indicate the temperature range and voltage-temperature limits designated in MIL–C–11015.
4. Temperature coefficient in parts per million per degree centigrade.

STD–C2

Figure 84. Capacitor color codes.

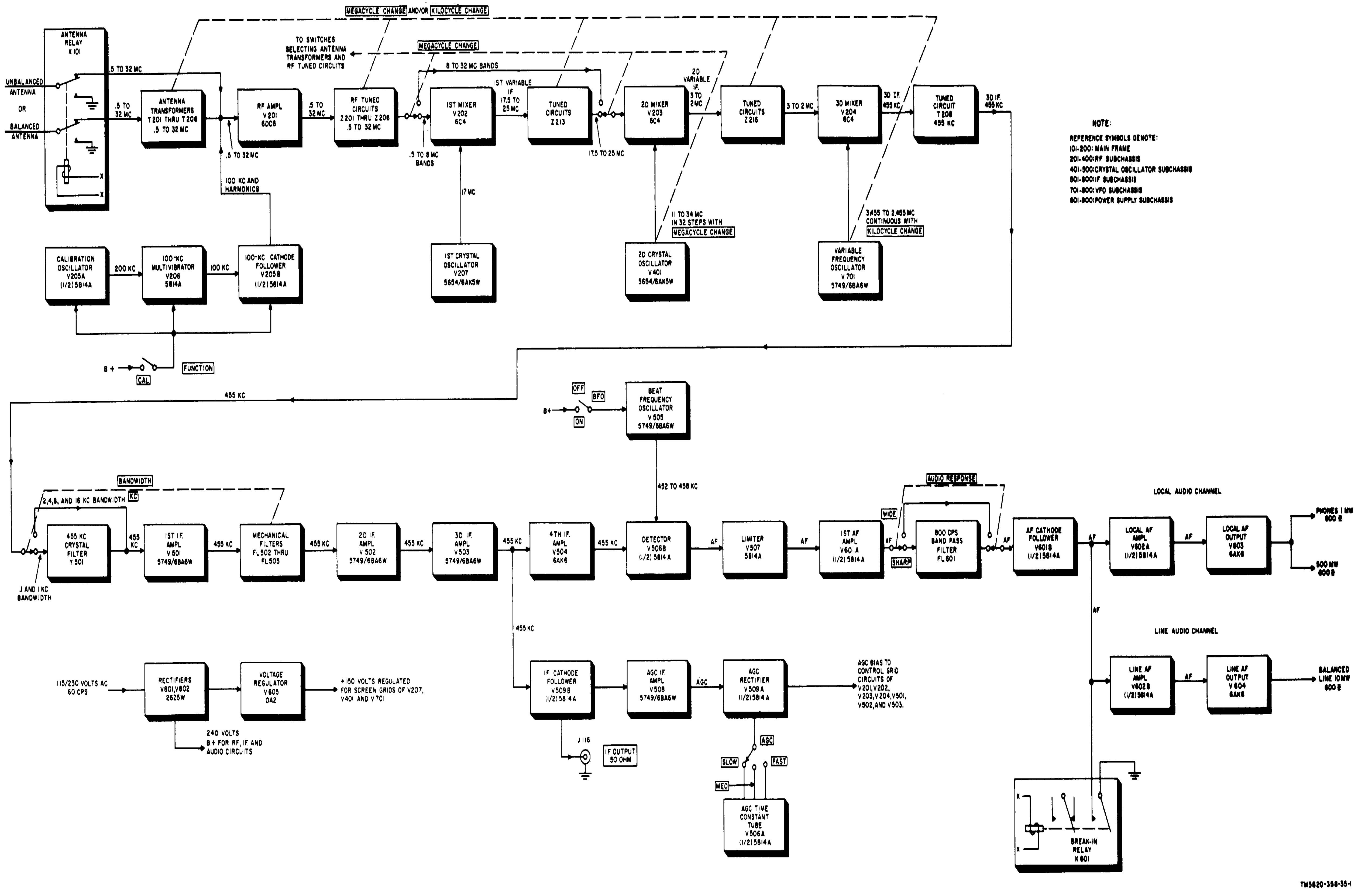


Figure 85. Radio Receiver R-390A/URR, block diagram.

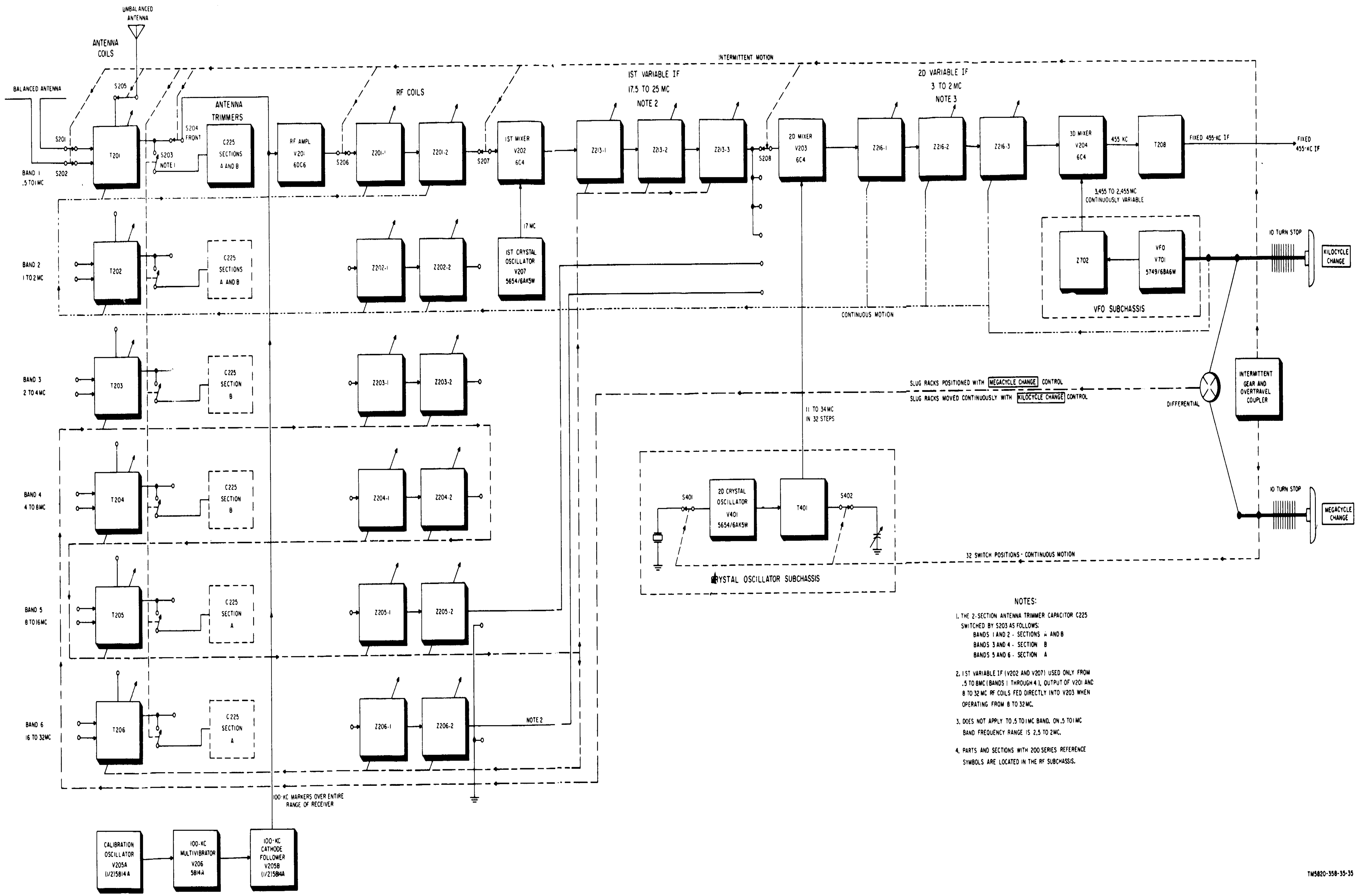


Figure 86. Tuning system showing relationship of stages, block diagram.

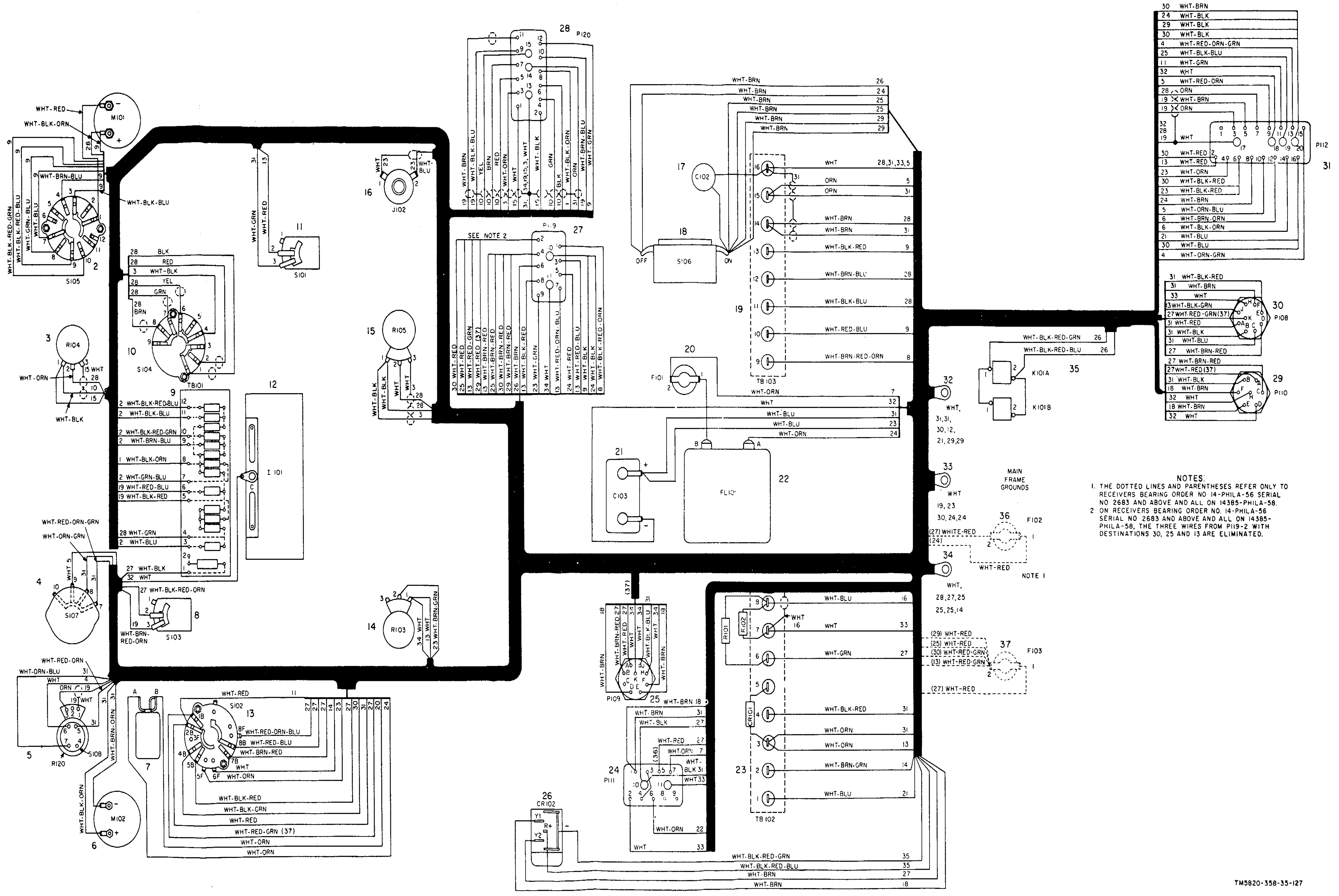


Figure 87. Radio Receiver R-390A/URR, main-frame wiring diagram.

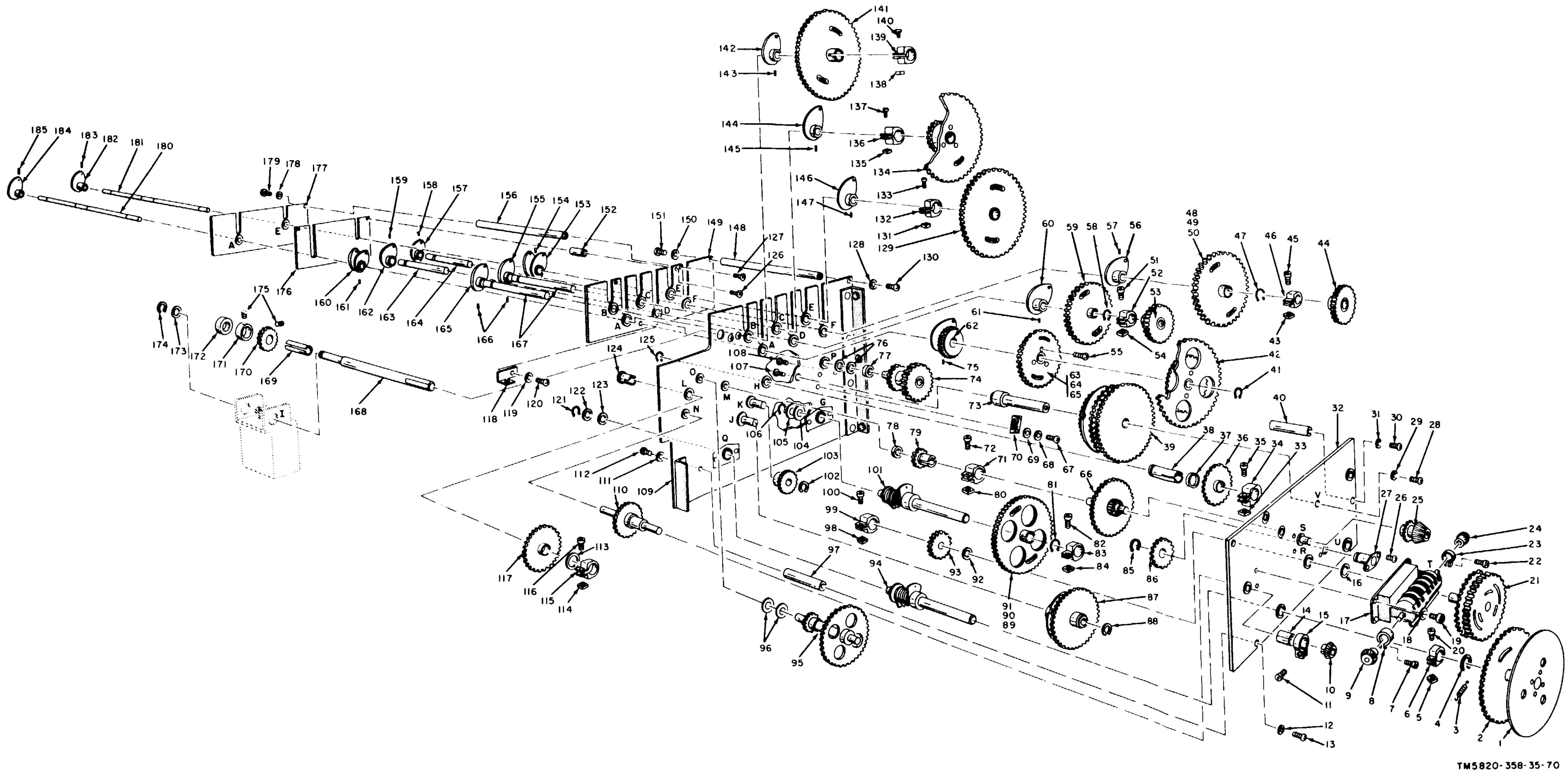


Figure 88. Rf gear train assembly, exploded view.

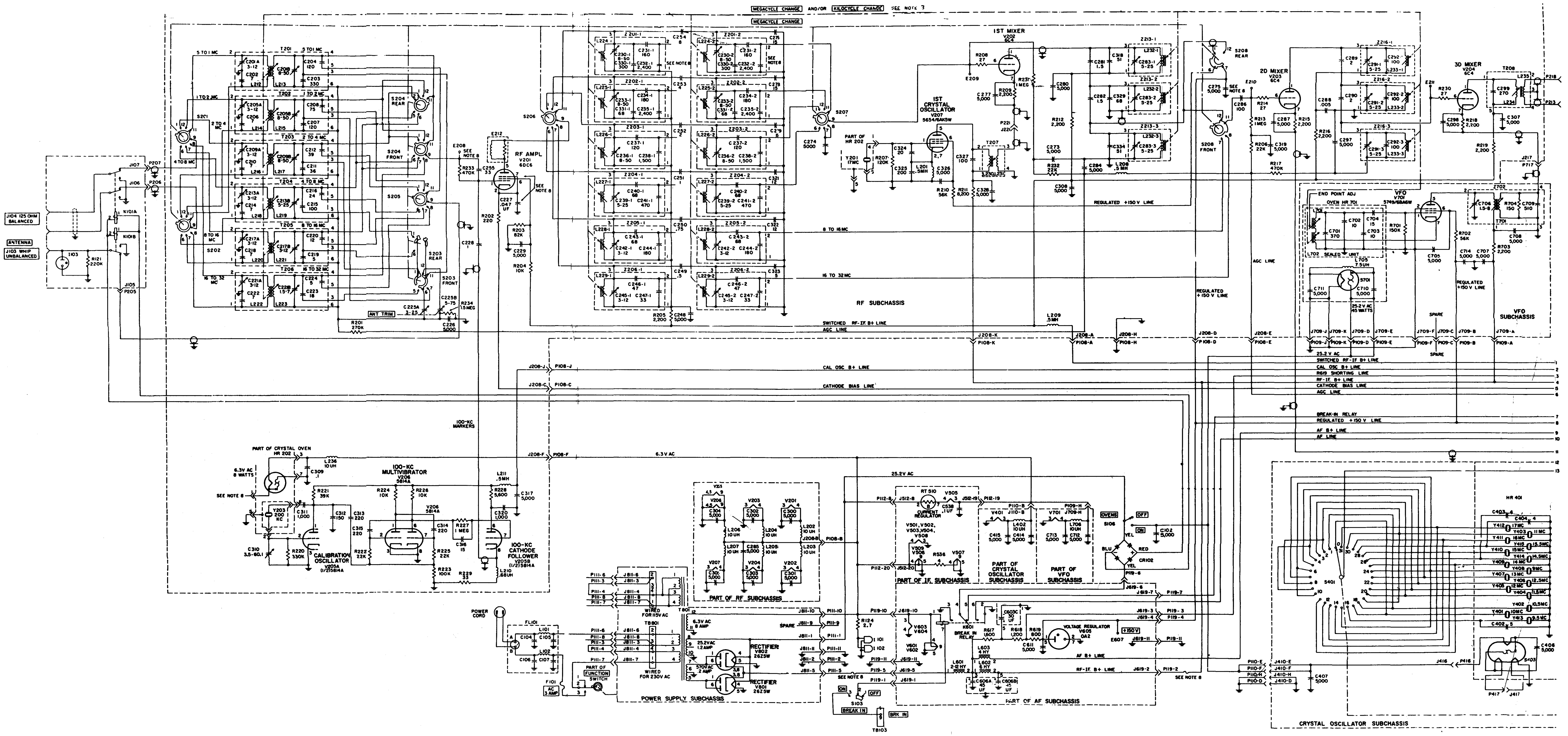


Figure 89 1. Radio Receiver R-390A/URR, main schematic diagram (part 1 of 2)

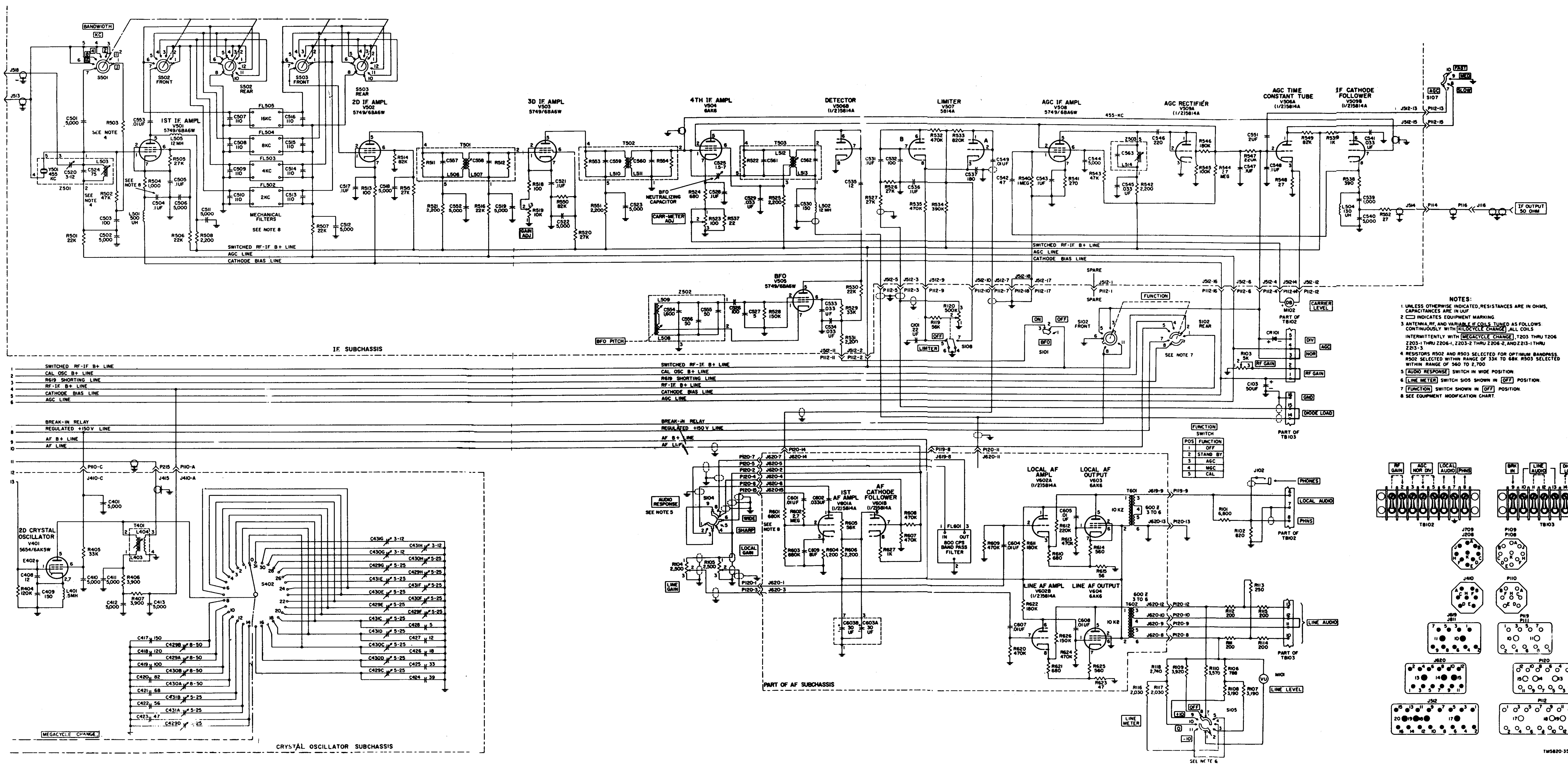


Figure 89 2. Radio Receiver R-390A/URR, main schematic diagram (part 2 of 2)

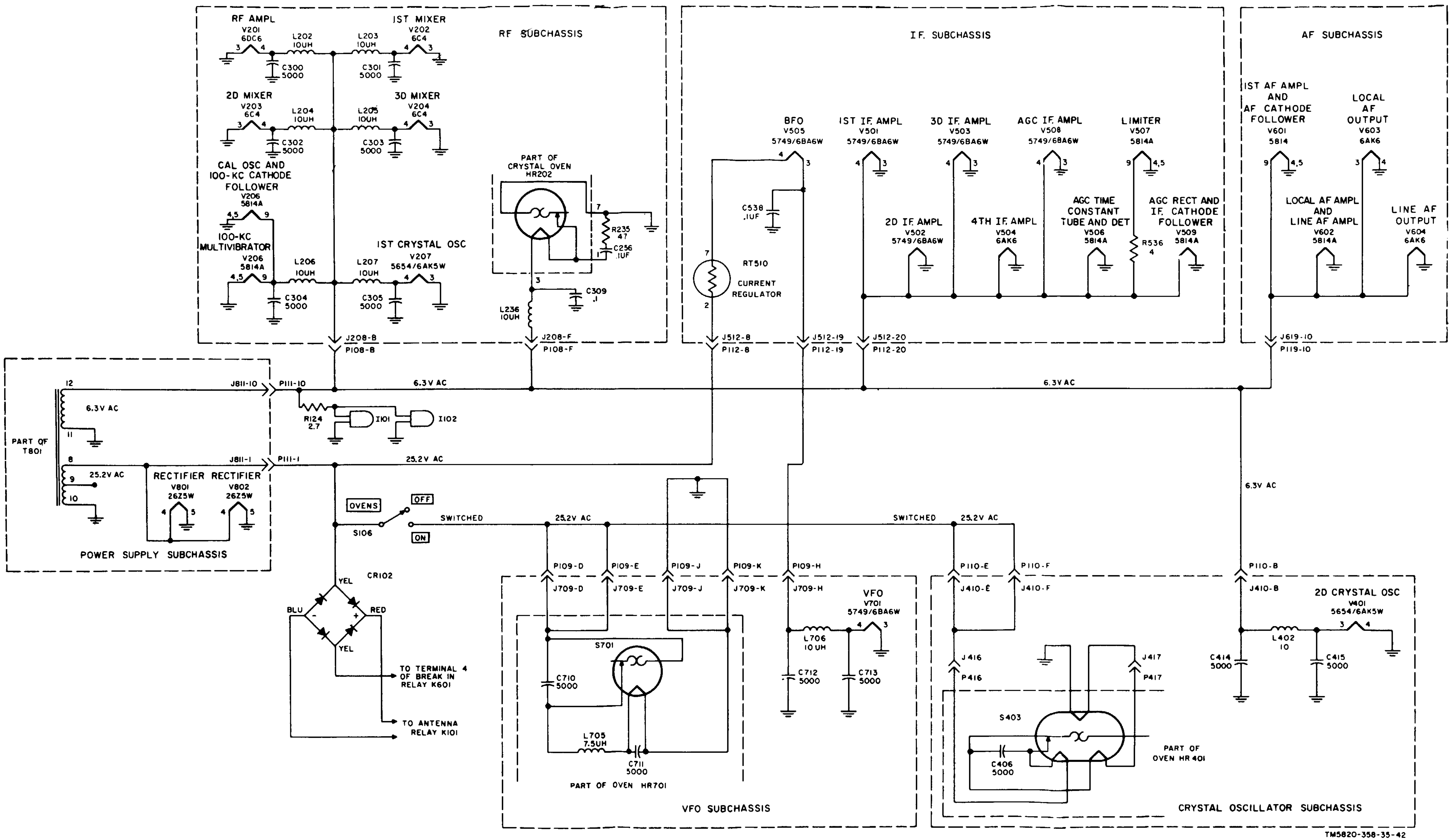


Figure 90. Filament and oven circuits, schematic diagram.

APPENDIX

REFERENCES

The following is a list of references available and applicable for field and depot maintenance of Radio Receiver R-390A/URR.

AR 320-5	Dictionary of United States Army Terms.
DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders.
FM 21-30	Military Symbols.
TM 11-1214	Instruction Book for Oscilloscope OS-8A/U.
TM 11-1214A	Oscilloscope OS-8C/U.
TM 11-2684	Audio Oscillators TS-312/FSM-1, TS-312A/FSM-1, and TS-382/U and Signal Generator TS-312B/FSM-1.
TM 11-2684A	Audio Oscillators TS-382A/U, TS-382B/U, TS-382D/U, and TS-382E/U.
TM 11-5017	Output Meters TS-585A/U, TS-585B/U, TS-585C/U, and TS-585D/U.
TM 11-5057	Frequency Meter AN/USM-26.
TM 11-5097	Spectrum Analyzers TS-723A/U, TS-723B/U, and TS-723C/U.
TM 11-5132	Voltmeter, Meter ME-30A/U and Voltmeters, Electronic ME-30B/U and ME-30C/U.
TM 11-5120	Frequency Meters AN/URM-32 and AN/URM-32A and Power Supply PP-1243/U.
TM 11-5511	Electronic Multimeter TS-505/U.
TM 11-6625-239-12	Electronic Multimeter TS-505A/U and TS-505B/U and Multimeters TS-505C/U and TS-505D/U.
TM 11-5527	Multimeter TS-352/U, TS-352A/U, and TS-352B/U.
TM 11-5540	Electric Light Assembly MX-1292/PAQ.
TM 11-5551A	R. F. Signal Generator Set AN/URM-25A.
TM 11-5551D	R. F. Signal Generator Set AN/URM-25D.
TM 11-5551E	R. F. Signal Generator AN/URM-25F.
TM 11-5820-358-10	Operator's Manual: Radio Receiver R-390A/URR.
TM 11-5820-358-20	Organizational Maintenance Manual: Radio Receiver R-390A/URR.
TM 11-5820-358-20P	Organizational Maintenance Repair Parts and Special Tools List: Receiver, Radio R-390A/URR.
TM 11-5820-358-35P	Field and Depot Maintenance Repair Parts and Special Tools List: Receiver, Radio R-390A/URR.
TM 11-6625-203-12	Operation and Organizational Maintenance: Multimeter AN/URM-105, including Multimeter ME-77/U.
TM 11-6625-274-12	Operator's and Organizational Maintenance Manual: Test Sets, Electron Tube TV-7/U, TV-7A/U, TV-7B/U, and TV-7D/U.
TM 11-6625-320-12	Operator's and Organizational Maintenance Manual: Voltmeter, Meter ME-30A/U and Voltmeters, Electronic ME-30B/U and ME-30C/U.

INDEX

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USA Sig Msl Spt Agcy (13)
Sig Fld Maint Shops (3)
USA Corps (3)
JBUSMC (2)
AFSSC (1)
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    11-16
    11-57
    11-98
    11-117
    11-155
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    11-557
    11-587
    11-592
    11-597

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The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 decagram = 10 grams = .35 ounce
1 hectogram = 10 decagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	Newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	Newton-meters	1.356	metric tons	short tons	1.102
pound-inches	Newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

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