TM 11-5095

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

FREQUENCY METER AN/URM-80

This copy is a reprint which includes current pages from Changes 3,4,6&8.

DEPARTMENT OF THE ARMY • OCTOBER 1955

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Be careful when working on the 240-volt dc plate supply circuits, and on the 110- or 220-volt ac input power circuits.

DON'T TAKE CHANCES!

CHANGE No. 8

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *27 May 1977*

FREQUENCY METER AN/URM-80 (NSN 6625-00-649-4286)

TM 11-5095, 6 October 1955, is changed as follows:

Title. The title is changed as indicated above.

Page 3, paragraph 2. Delete paragraph 2 and substitute the following:

2. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Maintenance forms, records, and reports which are to be used by maintenance personnel at all maintenance levels are listed in and prescribed by TM 38-750.

b. Report of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (packaging Improvement Report) as prescribed in AR 700-58 NAVSUPINST 4030.29/AFR 71-13/MCO P4030.29A, and DSAR 4145.8.

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 4610.33A/AFR 75-18/MCO P4610.19B and DSAR 4500.15.

Paragraph 2.1, last line. Change AMSEL-MA-C" to read "DRSEL-MA-Q".

After paragraph 2.1, add the following.

2.2. Administrative Storage

For procedures, forms, and records, and inspections required during administrative storage of this equipment, refer to TM 740-90-1.

2.3. Destruction of Army Materiel

Destruction of Army materiel to prevent enemy use shall be as prescribed in TM 750-244-2.

2.4. Reporting Equipment Improvement Recommendations (EIR)

EIR's will be prepared using DA Form 2407, Maintenance Request. Instructions for preparing EIR's are provided in TM 38-750 (The Army Maintenance Management System). EIR's should be mailed direct to Commander, US Army Electronics Command, ATTN: DRSEL-MA-Q, Fort Monmouth, New Jersey 07703. A reply will be furnished direct to you.

Page 37, figure 18. Change "J702 RF INPUT" to read "J701 RF INPUT".

Paragraph 44*c*, line 14. Change "J702" to read "J701".

Page 52, paragraph 59*b*(3). Change "J702" to read "J701".

Page 70, figure 39. Change "J701 3.6 MC CRYSTAL OUTPUT" to "J702 3.6 MC CRYSTAL OUTPUT" and "J702 RF INPUT" to "J701 RF INPUT".

Figure 40. Change "J702 RF" to "J701 RF".

Paragraph 75.5 Delete paragraph 75.5 and substitute the following:

75.5. Electrical Test

For the crystal check, set up the equipment as shown in figure 38.1.

a. Set all power switches to ON.

b. Direct-connect the AN/URM-80 3.6 MC CRYSTAL OUTPUT to the AN/USM-207 signal input. The AN/USM-207 should indicate

3.6. Megahertz ±5.4 Hertz

Paragraph 75.6*m*, chart. Delete the chart and substitute the following:

*This change supersedes change 7, 21 May 1975.

RANGE Setting (MC)	COARSE dial to block Mc	Film setting	Approximate signal generator frequency (MHz)
10-21.7	35	425300	14.8855
10-21.7	50	425300	21.2650
21.7-46.7	60	425300	25.5180
21.7-46.7	86	425300	36.5758
21.7-46.7	104	425300	44.2312
46.7-100	116	425300	49.3348
46.7-100	164	425300	69.7492
46.7-100	224	425300	95.2672

Page 75, chapter 7. Delete chapter 7.

Page 76, appendix I. Change the title of TM 38-750 from "The Army Equipment Record System and Procedures" to read "The Army Maintenance Management System (TAMMS)".

After TM 38-750 add the following:

TM 740-90-1 Administrative Storage of Equipment.

TM 750-244-2 Procedures for Destruction of Electronics Materiel to Prevent Enemy Use (Electronics Command).

By Order of the Secretary of the Army:

BERNARD W. ROGERS
General, United States Army
Chief of Staff

Official:

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

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Ft Huachuca (10)
Ft Carson (5)
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USAERDAW (1)
Units org under fol TOE:
(1 copy each unit)
6-615
6-616
7
7-100
11-97
11-98
11-117
11-187
11-500 (AA-AC)
17
17-100
29-1
29-15
29-16
29-21
29-25
29-26
29-35
29-36
29-41
29-51
29-55
29-56
29-75
29-76
29-79
29-105
29-109
30-25
30-29
37
37-100
47
55-405
55-407
57
57-100

NG: State AG (3)

USAR: None

For explanation of abbreviations used, see AR 310-50.

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FREQUENCY METER AN/URM-80

CHANGE No. 4

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *29 September 1966*

TM 11-5095, 6 October 1955 is changed as follows:

Note. The parenthetical references to a previous change (example: "page 1 of C 3") indicates that pertinent material was published in that change.

Page 3, paragraph 1.1 (page 1 of C 3), line 6. Insert after "technical bulletins": supply manuals (types 7, 8, and 9).

Paragraph 2 (page 1 of C 3). Delete subparagraph *c* and substitute:

c. Reporting Equipment Manual Improvements. The direct reporting by the individual user, of errors, omissions, and recommendations for improving this manual is authorized and encouraged. DA Form 2028 (Recommended Changes to DA Publications), will be used for reporting these improvements. This form will be completed using pencil, pen, or typewriter and forwarded direct to Commanding General U. S. Army Electronics Command, ATTN: AMSEL-MR-NMP-AD, Fort Monmouth, N. J., 07703.

Page 43, paragraph 50, chart. Delete the following *Items* and *References* from the chart:

Radio Receiver R-389/URR	TM 11-855
Signal Generator TS-465/U	TM 11-2642
Oscilloscope OS-8A/U	TM 11-1214
Electronic Multimeter TS-505/U	TM 11-5511

Add the following:

Radio Receiver R-390/URR	TM 11-5820-357-35
Signal Generator AN/USM-44	TM 11-6625-508-25
Oscilloscope AN/USM-117	TM 11-6625-640-15
Electronic Multimeter ME-26D/U	TM 11-6625-200-35

Page 70, add section V after section IV.

Section V. DEPOT OVERHAUL STANDARDS

75.1. Applicability of Depot Inspection Standards

The tests outlined in this chapter are designed to measure the performance capability of a repaired equipment. Equipment that is to be returned to stock should meet the standards given in these tests.

75.2. Applicable References

a. Repair Standards. Applicable procedures of the depots performing these tests and the general standard for repaired electronic equipment given in TB SIG 355-1, TB SIG 355-2, and TB SIG 355-3 form a part of the requirements for testing this equipment.

b. Technical Publication. The technical publication applicable to the equipment to be tested is TM 11-5095.

c. Modification Work Orders. Perform all modification work orders applicable to this equipment before making the tests specified. DA Pam 310-4 lists all available MWO's.

75.3. Test Facilities Required

The following items are needed for depot testing.

Item	Common name	Technical manual
Generator, Signal AN/USM-44.	Signal generator	TM 11-6625-508-10
Counter, Electronic, Digital Readout AN/USM-207.	Counter, Electronic, Digital, Readout	
Multimeter, Electronic ME-30C/U.	Electronic multimeter	TM 11-6625-320-12
Oscilloscope AN/USM-140B.	Oscilloscope	TM 11-6625-535-15-1
Meter Audio Level ME-71/FCC.	Audio level meter	TM 11-2151
Radio Receiver R-390/URR.	Radio receiver	FSN 5820-503-1242
Connector UG-274/U.	Connector	
Adapter UG-273/U.	Adapter	
Phone Plug PL-55.	Phone plug	
Headset H-3/ARR.	Headset	
Resistor, 50-ohm.	Resistor	
Radio Receiver R-220/URR.	Radio receiver	TM 11-882
Resistor, 600-ohm.	Resistor	

75.4. General Test Requirements

All tests must be conducted under the following conditions:

a. Power of 115 volts ac, ±10 percent, 60 cycles is required.

b. Allow equipment to warm up for 20 minutes.

c. Perform tests at normal room temperature.

75.5. Electrical Tests

For the crystal check, set up the equipment as shown in figure 38.1.

a. Set all power switches to ON.

b. Adjust the oscilloscope for sweeptrace.

c. Set Signal Generator AN/USM-44 for 3.6 mc. output as indicated on Counter, Electronic Digital Readout AN/USM-207.

d. A stationary or slow-moving Lissajous pattern should appear on the oscilloscope screen.

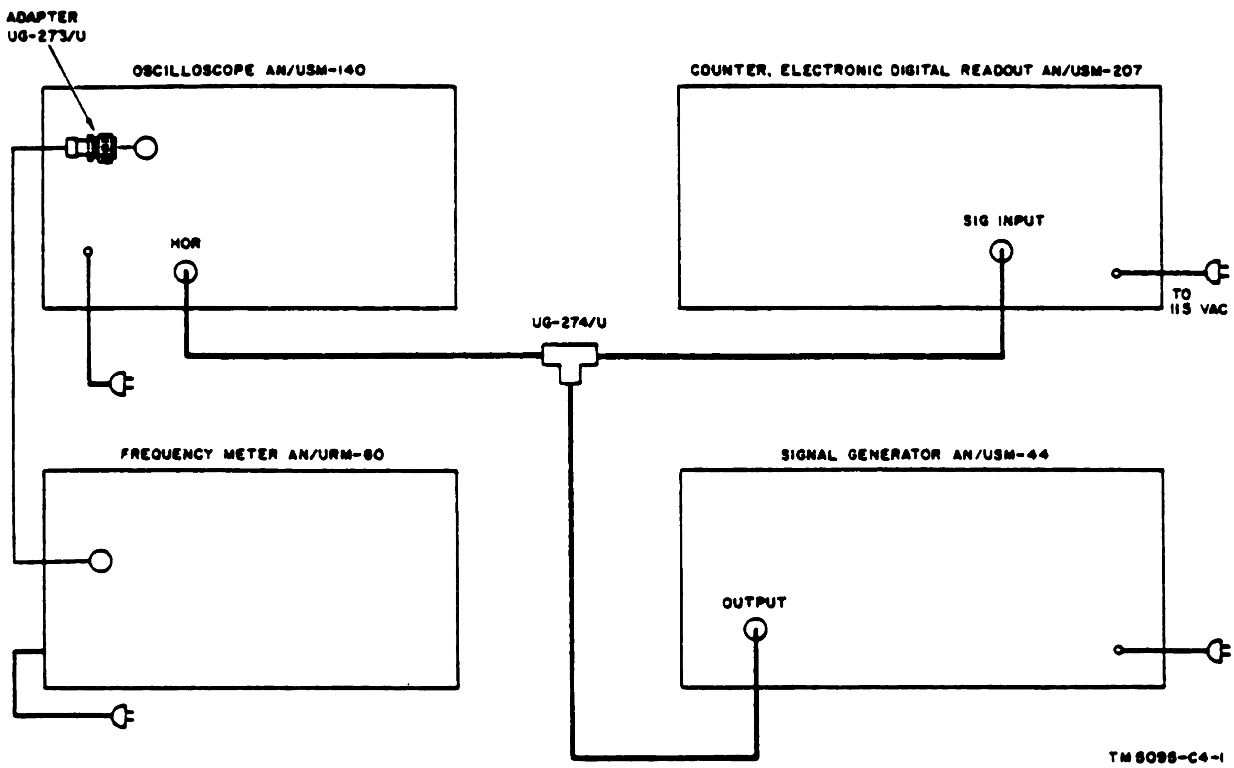

Figure 38.1. Crystal check.

75.6. Spurious Response Check

Set up the equipment as shown in figure 38.2.

a. Set all power switches to ON.

b. Set FINE dial to 425300.

c. Set COARSE dial to block 24.

d. Set the FUNCTION switch to COARSE.

e. Set the RANGE switch to 10-21.7 mc.

f. Turn the LEVEL control fully clockwise.

g. Peak the Frequency Meter AN/URM-80 TUNING METER by tuning Signal Generator AN USM-44 to approximately 10.2 mc; simultaneously adjust the Signal Generator attenuator until the TUNING METER indicates maximum deflection in the green LEVEL SET area.

h. Set the FUNCTION switch to FINE and adjust the Signal Generator for a zero beat in the headphones.

i. Set the FUNCTION switch to COARSE and adjust the COARSE DIAL for a peak indication on the TUNING METER.

j. Replace the headphone with audio level meter ME-71/FCC.

k. Set the FUNCTION switch to FINE and the FINE dial for maximum output indication on the audio level meter. Note and record the meter reading for later comparison.

l. Search for spurious responses over the width of the 24th block by rotating the FINE dial through its entire range. Any spurious responses found (indicated by a deflection on the audio level meter) must be at least 40 db below the true response noted in *e* above.

Note. Response not falling in a block is not to be considered a spurious response.

m. Repat *b* through *e* above for the eight blocks indicated in the chart below.

RANGE setting (mc)	COARSE dial to block No.	Film setting	Approximate signal generator frequency (mc)
10-21.7	35	423143	14.8
10-21.7	50	420800	21.0
21.7-46.7	60	416834	25.0
21.7-46.7	86	417443	35.9
21.7-46.7	104	427115	44.4
46.7-100	116	418793	48.5
46.7-100	164	422561	69.3
46.7-100	224	423215	94.8

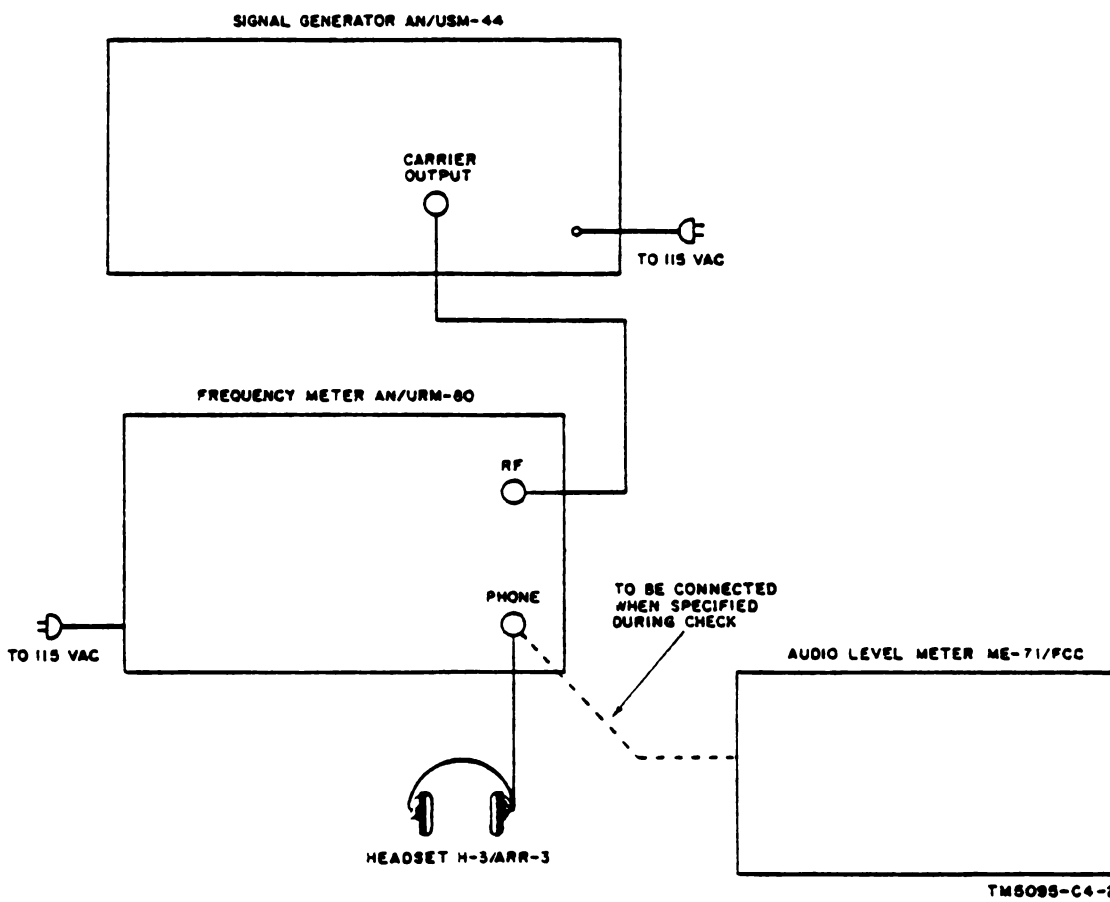

Figure 38.2. Spurious response check.

75.7. RF Output Check

Set up the equipment as shown in figure 38.3.

a. Turn the equipment power switches to ON.

b. Set the FUNCTION switch to FINE.

c. Set the RANGE switch to 10-21.7 mc.

d. Set the COARSE dial to ock 24.

e. Set FINE dial to 425300.

f. Set Receiver R-390/URR to 10.2 mc peak indicating meter on receiver.

g. Rotate the COARSE dial within the 24th block range for a peak indication on the receiver indicating meter, and note the receiver meter reading.

h. Disconnect the cable from the frequency meter RF INPUT jack, and connect it to the CARRIER OUTPUT jack on Signal Generator AN/USM-44.

i. Tune the signal generator output to approximately 10.2 megacycles ;peak the receiver indicating meter by slowly adjusting the signal generator frequency.

j. Adjust the signal generator attenuator until the receiver indicating meter deflection is the same as noted in *g* above.

k. The attenuator dial must indicate a minimum of 100 microvolts.

l. Repeat the procedure given in *a* through *d* above for the remaining two ranges listed in the chart below; use Receiver R-220/URR.

RANGE setting (mc)	COARSE dial to block No.	Film setting	Approximate signal generator frequency (mc)
21.7-46.7	86	417443	35.9
46.7-100	164	422561	69.3

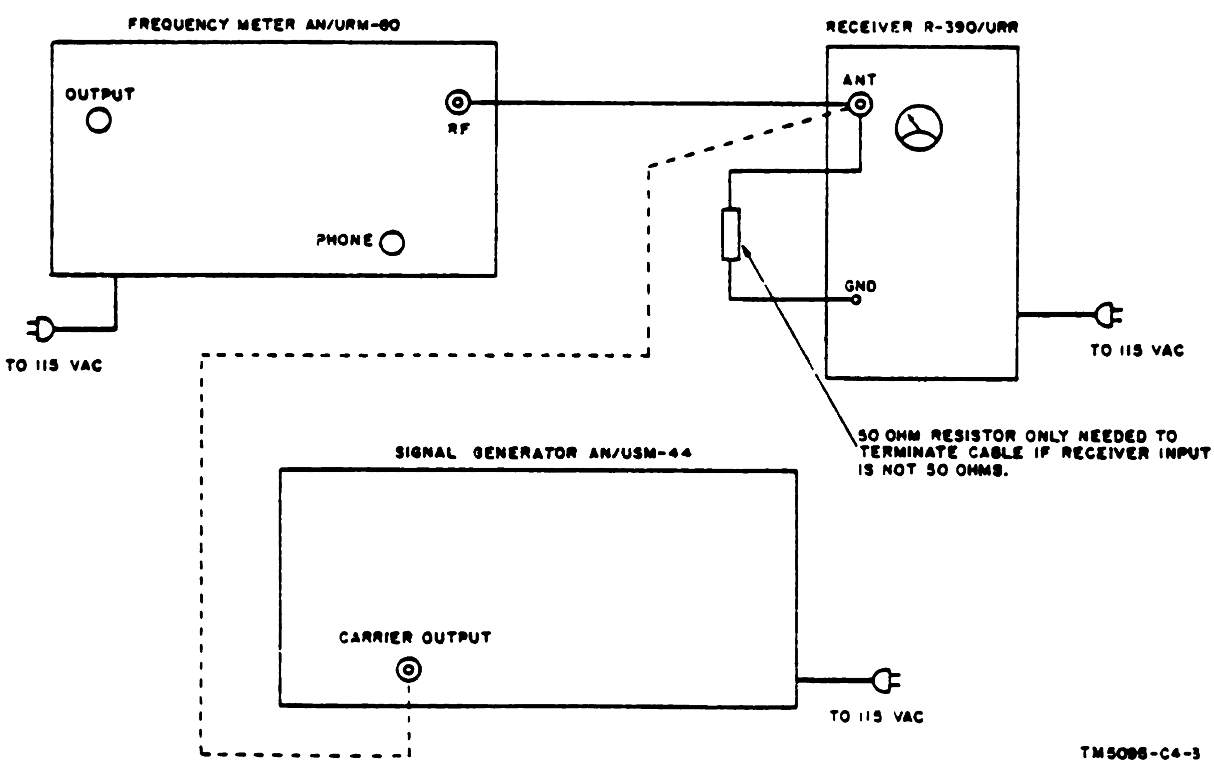

Figure 38.3. RF output check.

75.8. RF Noise Level Check

Set up the equipment as shown in figure 38.4.

a. Connect a 600-ohm, non-reactive resistor across the input terminals of Electronic Multimeter ME-30E U and set the multimeter for ac operation.

b. Insert the PL-55 phone plug in the PHONE jack of Frequency Meter AN URM-80. Connect the multimeter test leads to the phone plug as illustrated.

c. Set the equipment power switches to ON.

d. Set the RANGE switch to 10- 21.7 mc.

e. Set the FUNCTION switch to COARSE.

f. Set the LEVEL control fully clockwise.

g. Note the audio output noise voltage on Electronic Multimeter ME-30E U; it should be not greater than 0.1 volt.

h. Set the FUNCTION switch to FINE.

i. Repeat the procedure given in *g* above.

j. Repeat the procedure given in *a* through *i* above for the remaining two positions of the RANGE switch; the audio output noise voltage should be not greater than 0.1 volt.

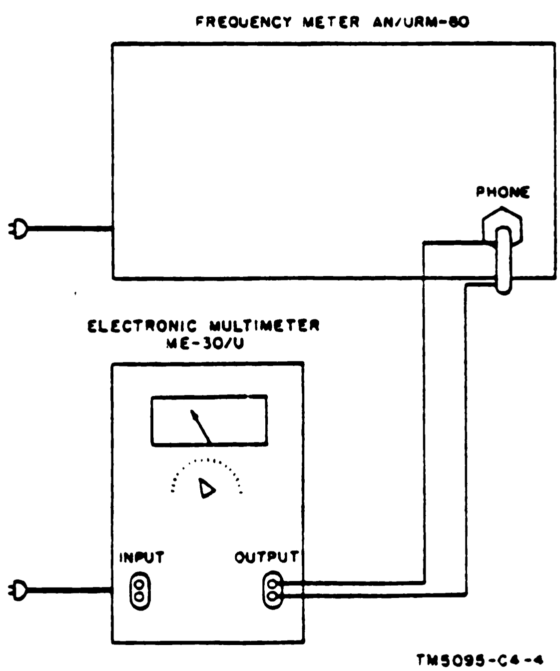

Figure 38.4. RF noise level check.

75.9. Sensitivity Check

Set up the equipment as shown in figure 38.2.

a. Set the FUNCTION switch to COARSE and the COARSE tuning dial to the center of block 24.

b. Set the LEVEL control fully clockwise.

c. Adjust the signal generator for a 10- millivolt unmodulated output.

d. Tune the signal generator around or near 10 megacycles until a tone is heard in the headphone, or until the TUNING METER indicates upscale.

e. Remove the headphone and replace it with Audio Level Meter ME-71/FCC.

f. Adjust the COARSE tuning dial for peak deflection on the audio level meter; adjust the LEVEL control for maximum indication of the TUNING METER in the green LEVEL SET area.

g. Adjust the signal generator to provide a 1 milliwatt (o dbm) audio output on the audio level meter; the signal generator should indicate 10 millivolts or less.

h. Set the FUNCTION switch to FINE.

i. Remove the audio level meter and replace with the headphones.

j. Adjust the signal generator attenuator for a 10-millivolt output and tune the frequency control for a zero beat in the headphone.

k. Replace the headphone with the audio level meter; retune the signal generator slightly for a peak deflection on the audio level meter.

l. Adjust the signal generator to provide a 1-milliwatt (o dbm) audio output on the audio level meter; the signal generator should indicate 10 millivolts or less.

Page 76, appendix (page 7 of C 3). Add to the references:

TM 11-882	Radio Receiving Sets AN/URR-29 and AN/URR-29X and Radio Receivers R-220/URR and R-644/URR.

TM 11-2151	Audio Level Meters ME-71A/FCC and ME-71B/FCC.
TM 11-6625-320-12	Organizational Maintenance Manual: Voltmeter, Meter ME-30A/U and Voltmeters, Electronic ME-30B/U, ME30C/U, and ME-30E/U.
TM 11-6625-508-10	Operator's Manual: Signal Generators AN/USM-44 and AN/USM-44A.
TM 11-6625-535-15	Organizational, DS, GS, and Depot Maintenance Manual: Oscilloscope AN/USM-140A.

By Order of the Secretary of the Army:

HAROLD K. JOHNSON,
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Chief of Staff.

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Army Dep (2) except
LBAD (14)
SAAD (30)
TOAD (14)
LEAD (7)
SHAD (3)
NAAD (5)
SVAD (5)
CHAD (3)
ATAD (10)
ERAD (10)
GENDEPS (2)
SIG Sec GENDEPS (5)
Sig Dep (12)
Sig FLDMS (2)
AMC (1)
USAERDAA (2)
USAERDAW (13)
USACRREL (2)
USA Engr R&D Labs (5)
MAAG, Iran (5)
USARSG (5)
Redstone Arsenal (5)
Units org under fol TOE:
(2 cys each)
5-600
5-605
5-615
6-616
7
7-100
11-6
11-56
11-57
11-58

11-97	29-51
11-98	29-55
11-117	29-56
11-127	29-75
11-155	29-76
11-157	29-79
11-158	29-105
11-587	29-109
11-592	30-25
11-597	30-29
11-608	31-105
17	37
17-100	37-100
29-1	47
29-15	55-50
29-16	55-147
29-21	55-405
29-25	55-407
29-26	57
29-35	57-100
29-36	
29-41	

NG: State AG (3); units — same as active Army except allowance is one (1) copy to each unit.

USAR: None.

For explanation of abbreviations used, see AR 320-50.

☆ U.S. GOVERNMENT PRINTING OFFICE : 1984 O - 421-302 (4436)

TECHNICAL MANUAL

FREQUENCY METER AN/URM-80

TM 11-5095
CHANGES No. 3

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *10 September 1963*

TM 11-5095, 6 October 1955, is changed as indicated so that the publication also applies to the following equipment:

Nomenclature	*Order No.*	*Serial No.*
Frequency Meter FR-5A/U	3401-PP-59	1 through 525

Page 3, chapter 1 (as changed by C 2, 24 May 1960). Add the following note below the title of chapter 1:

Note. Frequency Meter FR-5A/U is similar to Frequency Meter FR-5/U. Information in this manual applies to both equipments unless otherwise specified.

Paragraph 1. Add paragraph 1.1 after paragraph 1.

1.1. Index of Publications

Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to your equipment. DA Pam 310-4 is an index of current technical manuals, technical bulletins, supply bulletins, lubrication orders, and modification work orders that are available through publications supply channels. The index lists the individual parts (-10, -20, -35P, etc) and the latest changes to and revisions of each equipment publication.

Delete paragraph 2 and substitute:

2. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Use equipment forms and records in accordance with instructions in TM 38-750.

b. Report of Damaged or Improper Shipment. Fill out and forward DD Form 6 (Report of Damaged or Improper Shipment) as prescribed in AR 700-58 (Army), NAVSANDA Publication 378 (Navy), and AFR 71-4 (Air Force).

c. Reporting of Equipment Manual Improvements. The direct reporting by the individula user, of errors, omissions, and recommendations for improving this equipment manual is authorized and encouraged. DA Form 2028 will be used for reporting these improvements. This form will be completed in triplicate using pencil, pen, or typewriter. The original and one copy will be forwarded direct to Commanding Officer, U.S. Army Electronics Materiel Support Agency, ATTN: SELMS-MP, Fort Monmouth, N. J. One information copy will be furnished to the individual's immediate supervisor (e.g., officer, noncommissioned officer, supervisor, etc).

Page 5, paragraph 7 (as changed by C2, 24 May 1960). Add subparagraph *e* after subparagraph *d*.

e. Adapter UG-641/U. Two Adapters UG-641/U are supplied with the equipment, to be utilized in converting from a receptacle to a binding post when required.

Page 12, paragraph 18*a*(4) (as changed by C2, 24 May 1960). Add the following to subparagraph (4):

> Be sure that the hairline falls on a numbered black rectangle. If not, rotate the FINE tuning control until a beat is found for which the hairline does fall on a numbered rectangle.

*This change supersedes C 2, 24 May 1960.

Page 15, chapter 4. Delete the chapter heading and substitute:

MAINTENANCE INSTRUCTIONS

Delete sections I and II and substitute:

Section I. OPERATOR'S MAINTENANCE

25. Scope of Operator's Maintenance

The maintenance duties assigned to the operator of Frequency Meter AN/URM-80 are listed below, together with a reference to the paragraphs covering the specific maintenance functions. The duties assigned do not require tools or test equipment other than those issued with Frequency Meter AN/URM-80.

a. Daily preventive maintenance checks and services (par. 26.2).

b. Weekly preventive maintenance checks and services (par. 26.3).

c. Cleaning (par. 26.4).

26. Preventive Maintenance

Preventive maintenance is the systematic care, servicing, and inspection of equipment to prevent the occurrence of trouble, to reduce downtime, and to assure that the equipment is serviceable.

a. Systematic Care. The procedures given in paragraphs 26.2, 26.3, and 26.4 cover routine systematic care and cleaning essential to proper upkeep and operation of the equipment.

b. Preventive Maintenance Checks and Services. The preventive maintenance checks and services charts (pars. 26.2 and 26.3) outline functions to be performed at specific intervals. These checks and services are to maintain Army electronic equipment in a combat-serviceable condition; that is, in good general (physical) condition and in good operating condition. To assist operators in maintaining combat serviceability, the charts indicate what to check, how to check, and what the normal conditions are; the *references* column lists the illustrations, paragraphs, or manuals that contain detailed repair or replacement procedures. If the defect cannot be remedied by the operator, higher echelon maintenance or repair is required. Records and reports of these checks and services must be made in accordance with the requirements set forth in TM 38-750.

26.1. Preventive Maintenance Checks and Services Periods

Preventive maintenance checks and services of Frequency Meter AN/URM-80 are required daily and weekly. Paragraphs 26.2 and 26.3 specify the items to be checked and serviced. In addition to the routine daily checks and services, the equipment should be rechecked and serviced immediately before going on a mission and as soon after completion of the mission as possible.

26.2. Daily Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Frequency Meter AN/URM-80.	Check the equipment for completeness and general condition.	Pars. 6 and 8; and TM 11-6625-284-10P.
2	Exterior surfaces	Clean exterior surfaces of the equipment	Par. 26.4.
3	Knobs, controls, and switches	During operation (sequence No. 7), check knobs, controls, and switches for proper mechanical and electrical action. Action should be positive without blacklash, binding, or scraping.	None.
4	Meters	During operation (sequence No. 7), check the meter for broken glass and erratic pointer movement.	None.
5	OVEN HTR and pilot lamps	During operation (sequence No. 7), check for burned-out OVEN HTR and pilot lamps.	None.
6	MEGACYCLES dial glass	Inspect the MEGACYCLE dial glass for breaks	None.
7	Operation	During operation, be alert for any unusual operation or condition.	None.

26.3. Weekly Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Cords and cables	Inspect cords and cables for cuts, cracks, fraying, and broken terminations.	None.
2	Hardware	Inspect all exterior hardware for looseness and damage.	None.
3	Preservation	Inspect exterior metal surfaces for bare spots, rust, and corrosion. Refer to higher echelon for repair.	None.

26.4 Cleaning

Inspect the exterior of Frequency Meter AN/URM-80. The exterior surfaces should be clean, and free of dust, dirt, grease, and fungus.

a. Remove dust and loose dirt with a clean soft cloth.

Warning: **Cleaning compound is flammable and its fumes are toxic. Provide adequate ventilation. *Do not* use near a flame.**

b. Remove grease, fungus, and ground-in dirt from the cases; use a cloth dampened (not wet) with Cleaning Compound (FSN 7930-395-9542).

Caution: **Do not press on the meter and dial faces (glass) when cleaning.**

c. Clean the front panel and control knobs; use a soft clean cloth. If necessary; use mild soap and water to remove dirt.

Section II. ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

27. Scope of Organizational Maintenance

The maintenance duties assigned to the organizational repairman of Frequency Meter AN/URM-80 are listed below, together with a reference to the paragraph covering the specific maintenance function. The duties assigned do not require tools or test equipment other than those issued with Frequency Meter AN/URM-80.

a. Monthly preventive maintenance checks and services (par. 30).

b. Lubrication (pars. 31 and 32).

c. Touchup painting instructions (par. 34).

d. Troubleshooting (pars. 35-38).

28. Organizational Preventive Maintenance

a. Organizational preventive maintenance is the systematic care, inspection, and servicing of equipment to maintain it in serviceable condition, prevent breakdown, and assure maximum operational capability. Preventive maintenance is the responsibility of all echelons concerned with the equipment and includes the inspection, testing, and repair or replacement of parts, subassemblies, or units that inspection and tests indicate would probably fail before the next scheduled periodic service. Preventive maintenance checks and services of Frequency Meter AN/URN-80 at the second echelon level are made at monthly intervals unless otherwise directed by the commanding officer.

b. Maintenance forms and records to be used and maintained on this equipment are specified in TM 38-750.

29. Monthly Maintenance

Perform the maintenance functions indicated in the monthly preventive maintenance checks and services chart (par. 30) once each month. A month is defined as approximately 30 calendar days of 8-hour-per-day operation. If the equipment is operated 16 hours a day, the monthly preventive maintenance checks and services should be performed at 15-day intervals. Adjustment of the maintenance interval must be made to compensate for any unusual operating conditions. Equipment maintained in a standby (ready for immediate operation) condition must have monthly preventive maintenance checks and services performed on it. Equipment in limited storage (requires service before operation) does not require monthly preventive maintenance.

30. Monthly Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Publications	Inspect the manual to see if it is complete and in usable condition. Be sure that all changes to the manual are on hand.	DA Pam 310–4.
2	Modification work orders	Check to see that all URGENT MWO's have been applied and that all NORMAL MWO's have been scheduled.	DA Pam 310–4.
3	Frequency Meter AN/URM–80	Check the equipment for completeness and general condition.	Pars. 6 and 8; and TM 11–6625–284–10P.
4	Preservation	Inspect exterior metal surfaces for bare spots, rust, and corrosion.	Par. 34.
5	Knobs, controls, and switches	During operation (sequence No. 15), check knobs, controls and switches for proper mechanical and electrical action. Action should be positive, without backlash, binding, or scraping.	None.
6	Meter	During operation (sequence No. 15), check the meter for broken glass and erratic pointer movement.	None.
7	OVEN HTR and pilot lamp	During operation (sequence No. 15), check for a burned-out OVEN HTR and pilot lamp.	None.
8	MEGACYCLE dial glass	Inspect the MEGACYCLE dial glass for breaks	None.
9	Cords and cables	Inspect cords and cables for cuts, cracks, fraying, and broken terminations.	None.
10	Hardware	Inspect all hardware for looseness and damage	None.
11	Fuses	Check fuses for proper value and number (spares)	Par. 8, and fig. 29.
12	Cleanliness	Clean exterior surfaces of the equipment. Check for cleanliness of switch contacts.	Par. 26.4.
13	Resistors and capacitors	Check resistors and capacitors for cracks, blistering, or other detrimental effects.	Figs. 31, 33, and 35–38.
14	Variable capacitors	Check variable capacitors for dirt, corrosion, or deformed plates.	Figs. 27 and 28.
15	Operation	Perform the equipment performance check (para 38). Refer equipment to higher echelon where necessary.	Par. 38.

Page 16. Delete figure 6.

Page 17. Delete figure 7.

Page 19, figure 8 (page 2 of C 2). Delete figure 8 and substitute new figure 8.

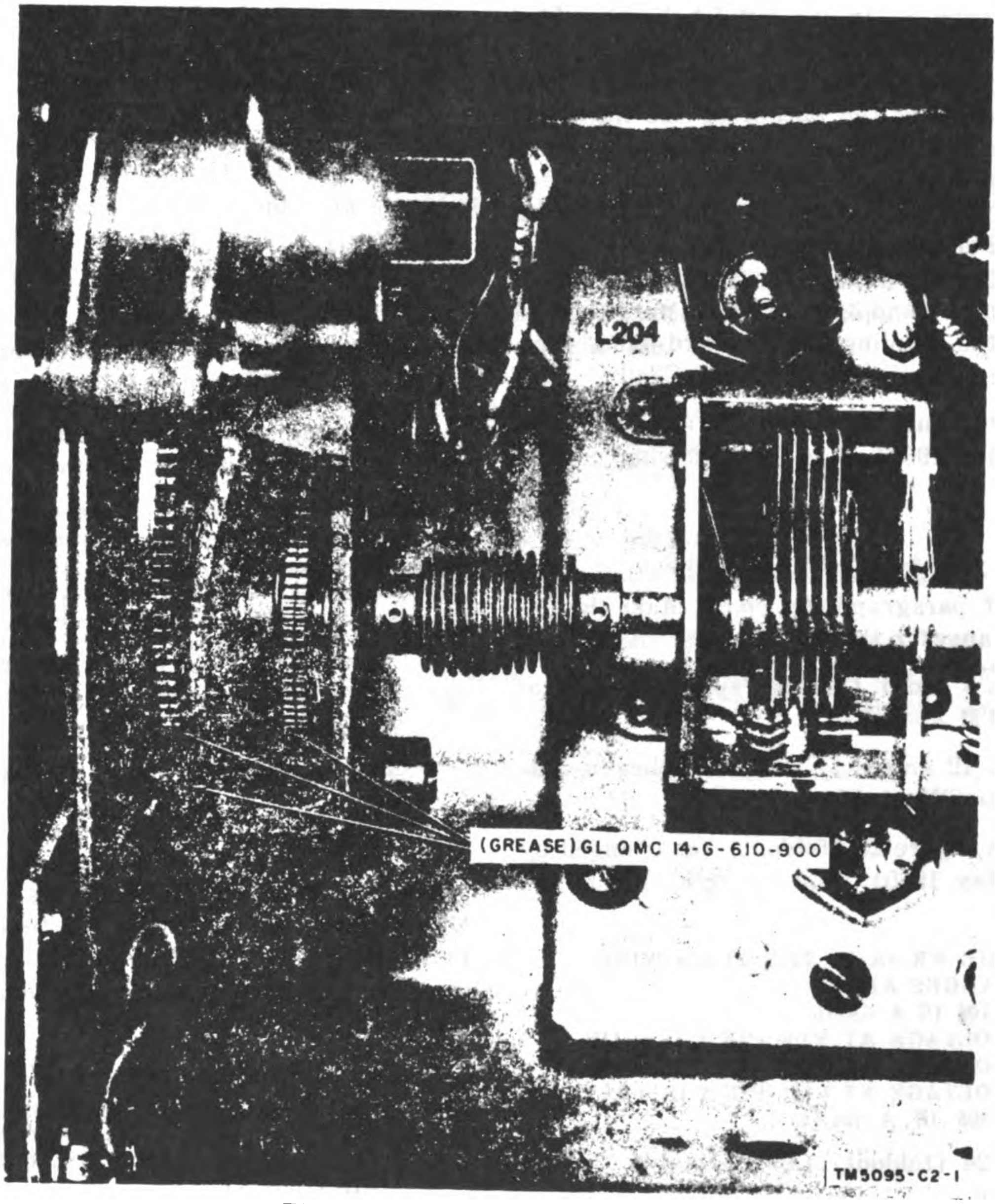

Figure 8. Typical lubrication points.

Delete paragraph 34 and substitute:

34. Touchup Painting Instructions

Clean rust and corrosion from metal surfaces by lightly sanding them with fine sandpaper. Brush two thin coats of paint on the bare metal to protect it from further corrosion. Refer to the applicable cleaning and refinishing practices specified in TM 9-213.

Page 24, figure 9 (foldout). (As changed by C 2, 24 May 1960). Add the following note:

NOTE

IN THE FR-5A/U, V305 IS A 6AH6.

Page 36, figure 17 (as changed by C 2, 24 May 1960). Add the following note:

NOTE

IN THE FR-5A/U, V305 IS A 6AH6.

Page 38, paragraph 45*b* (as changed by C 2, 24 May 1960). Add the following at the end of subparagraph *b*: In the FR–5A/U, an added component, C240, 2.2 $\mu\mu$f, is added between pins 6 and 8 of V202. This increases the coupling that feeds the output of the harmonic generator to J202 when the frequency meter is used as a signal generator (See par. 45*a* for description of C205, band 1.) Add the following at the end of subparagraph *c*: In the FR–5A/U, an added component, C241, 0.51 $\mu\mu$f, is added between pins 1 and 3, of V202. Its purpose is to increase the coupling for the third band, similar to the operation of C205 and C240.

Page 40, figure 20 (foldout) (as changed by C 2, 24 May 1960). Add the following note to figure 20.

NOTE
IN THE FR–5A/U, V106 IS A 6AH6.

Page 43, paragraph 50*a*, chart. Make the following changes to the "References" column:

Lines 3 and 4. Change "applicable Literature" to TM 11–2665.

Lines 12 and 13. Change "applicable Literature" to TM 11–5094.

Page 44, figure 23 (foldout) (as changed by C 2, 24 May 1960). Add the following to the notes:

6. IN THE FR–5A/U, THE FOLLOWING CHANGES APPLY:
   V106 IS A 6AH6.
   VOLTAGE AT V106 PIN 5 IS +44V.
   VOLTAGE AT V106 PIN 6 IS +44V.
   VOLTAGE AT V106 PIN 7 IS +0.7V.
   V305 IS A 6AH6.

Figure 24 (foldout) (as changed by C 2, 24 May 1960).

Add the following to the notes:

5. IN THE FR–5A/U, THE FOLLOWING CHANGES APPLY:
   V106 IS A 6AH6.
   VOLTAGE AT V106 PIN 5 IS +78V.
   VOLTAGE AT V106 PIN 6 IS +78V.
   VOLTAGE AT V106 PIN 7 IS +2.4V.
   V305 IS A 6AH6.

Figure 25 (foldout) (as changed by C 2, 24 May 1960).

Add the following to the notes:

7. IN THE FR–5A/U, THE FOLLOWING CHANGES APPLY:
   V106 IS A 6AH6.
   VOLTAGE AT V106 PIN 5 IS +44V.
   VOLTAGE AT V106 PIN 6 IS +44V.
   VOLTAGE AT V106 PIN 7 IS +0.65V.
   V305 IS A 6AH6.
   VOLTAGE AT V305 PIN 7 IS +33V (BAND 3).

Page 56, figure 31 (as changed by C 2, 24 May 1960). Change the identification of resistor "R110" to: R101. Change the identification of resistor "R101" to: R110.

Page 58, paragraph 66*a* (as changed by C 2, 24 May 1960). Make the following changes:

Subparagraph (1) (*b*). Add the following note below subparagraph (*b*):

Note. The rubber sleeve on the tuning dial shaft was placed on the shaft as an additional protective measure. However, on some sets the rubber sleeve may prevent full band coverage. If this difficulty is encountered, remove the rubber sleeve.

Subparagraph (2) (*b*). Add the following sentence: Refer to the note in (1) (*b*) above.

Subparagraph (3) (*b*). Add the following sentence: Refer to the note in (1) (*b*) above.

Page 70, figure 39 (foldout) (as changed by C 2, 24 May 1960). In the RF tuner section, move the tap on coil L214 so that it is located between ground and the connection to C207, section G.

Figure 39 (foldout) (as changed by C 2, 24 May 1960). Add the following to the notes:

4. IN THE FR–5A/U, THE FOLLOWING CHANGES APPLY:
   V106 IS A 6AH6.
   V305 IS A 6AH6.
   ADD C240, 2.2 MMF, BETWEEN PINS 6 AND 8 OF V202.
   ADD C241, 0.51 MMF, BETWEEN PINS 1 AND 3 OF V202.

Figure 42 (foldout) (as changed by C 2, 24 May 1960). Change "C207B" (located above C217) to C207C.

Figure 42 (foldout) (as changed by C 2, 24 May 1960). Add the following note to figure 42:

NOTE
IN THE FR-5A/U, THE FOLLOWING CHANGES APPLY:
ADD C240 BETWEEN PINS 6 AND 8 OF XV202.
ADD C241 BETWEEN PINS 1 AND 8 OF XV202.

Page 76. Add the following appendix after section II.

APPENDIX
REFERENCES

Following is a list of applicable publications available to the operator and repairman of Frequency Meter AN/URM-80.

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders.
TM 9-213	Painting Instructions for Field Use.
TM 11-855	Radio Receiver R-389/URR.
TM 11-1214	Instruction Book for Oscilloscope OS-8A/U.
TM 11-2665	Frequency Calibrator Set AN/URM-18.
TM 11-5094	Frequency Meters AN/URM-79 and AN/URM-82.
TM 11-5511	Electronic Multimeter TS-505/G.
TM 11-5551B	R. F. Signal Generator Set AN/URM-25B.
TM 11-6625-284-10P	Operator Maintenance Repair Parts and Special Tools List: Frequency Meter AN/URM-80.
TM 11-6625-284-20P	Organizational Maintenance Repair Parts and Special Tools List and Maintenance Allocation Chart: Frequency Meter AN/URM-80.
TM 11-6625-284-35P	Field and Depot Maintenance Repair Parts and Special Tools List: Frequency Meter AN/URM-80.
TM-38-750	The Army Equipment Record System and Procedures.

BY ORDER OF THE SECRETARY OF THE ARMY:

EARLE G. WHEELER,
General, United States Army,
Chief of Staff.

Official:

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

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OS Maj Comd (3)
OS Base Comd (2)
LOGCOMD (2)
USAECOM (5)
USAMICOM (4)
USASCC (4)
MDW (1)
Armies (2)
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USA Corps (3)
USATC AD (2)
USATC Engr (2)
USATC Inf (2)
USATC Armor (2)
USASTC (5)
Instl (2) except
Ft Monmouth (65)
Svc Colleges (2)
Br Svc Sch (2) except USASCS (25
GENDEP (OS) (2)
Sig Dep (OS) (12)
Sig Sec, GENDEP (5)
Army Dep (2) except
Ft Worth (8)
Lexington (12)
Sacramento (28)
Tobyhanna (12)
Rock Island Arsenal (5)
USAEPG (3)
USA Comm Agcy (5)
USAABELCTBD (2)
USA Elct RD Actv, White Sands (13)
USA Elct RD Actv, Ft Huachuca (2)
USA Trans Tml Comd (1)
Army Tml (1)
POE (1)
USAOSA (1)
AMS (1)
WRAMC (1)
AFIP (1)
Army Pic Cen (2)
USA Mbl Spt Cen (1)
USA Elct Mat Agcy (12)
Chicago Proc Dist (1)
USARCARIB Sig Agcy (1)
Sig Fld Maint Shop (3)
Units org under fol TOE
(2 cy ea UNOINDC):
5–600
5–605
6–615
6–616
7
7–52
7–100
11–5
11–6
11–17
11–38
11–55
11–56
11–58
11–155
11–158
11–500 (AA–AC) (4)
11–608
17
17–100
29–1
29–15
29–16
29–21
29–25
29–26
29–35
29–36
29–51

29–55	29–105
29–56	37
29–75	37–100
29–76	57
29–79	57–100

NG: State AG (3); units — same as Active Army except allowance is one copy to each unit.

USAR: None.

For explanation of abbreviations used, see AR 320–50.

U.S. GOVERNMENT PRINTING OFFICE : 1970 O - 430-505 (5039A)
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TECHNICAL MANUAL No. 11-5095

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *6 October 1955*

FREQUENCY METER AN/URM-80

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. This manual contains instructions for the installation, operation, maintenance, and repair of Frequency Meter AN/URM–80 (fig. 1).

b. Forward comments on this publication directly to Commanding Officer, The Signal Corps Publications Agency, Fort Monmouth, New Jersey, ATTN: Standards Division.

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of Army materiel and

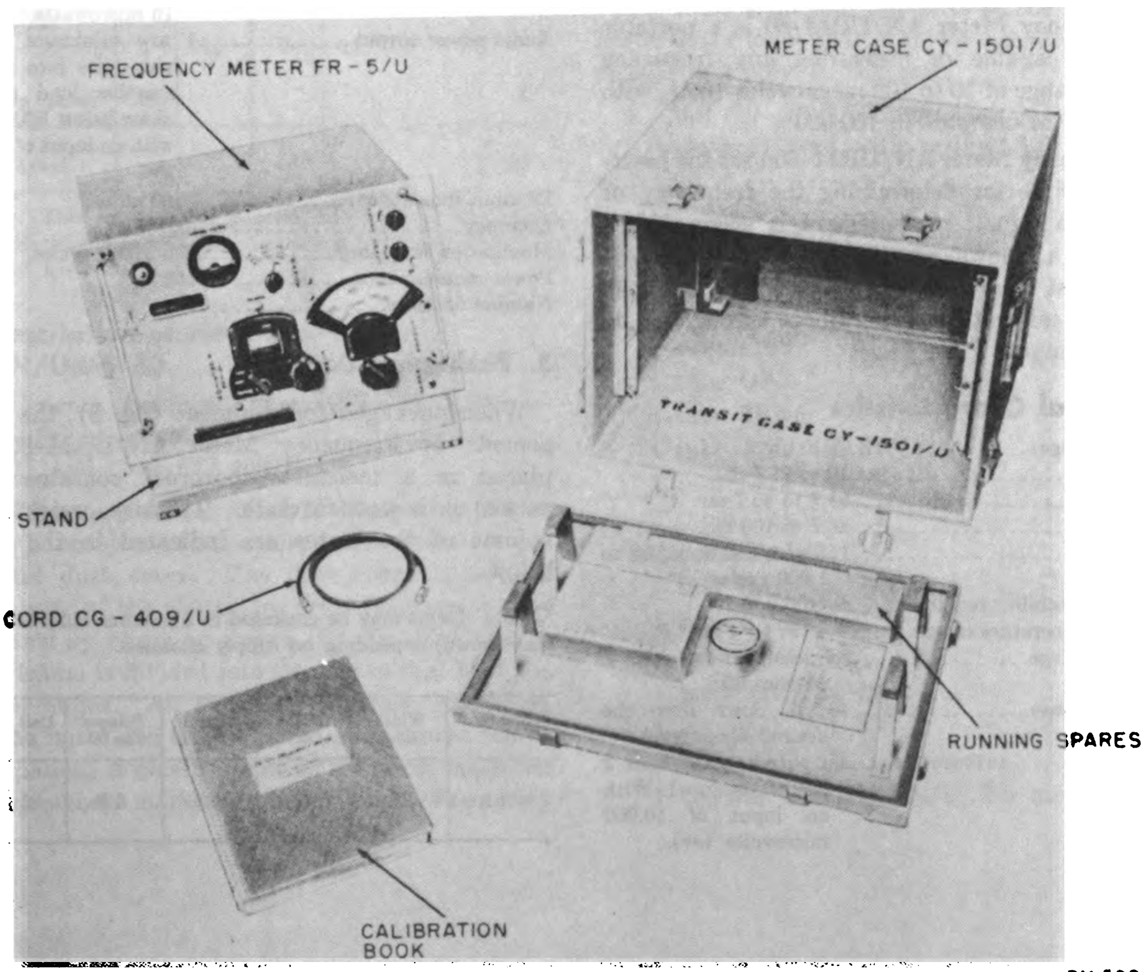


Figure 1. Frequency AN/URM–80.

equipment and when performing preventive maintenance.

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745-45-5 (Army); Navy Shipping Guide, Article 1850-4 (Navy); and AFR 71-4 (Air Force).

b. DA Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the office of the Chief Signal Officer, as prescribed in SR 700-45-5.

c. DD Form 535, Unsatisfactory Report, will be filled out and forwarded to Commanding General, Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio, as prescribed in SR 700-45-5 and AF TO 00-35D-54.

d. DA Form 11-238, Operator First Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar) will be prepared in accordance with instructions on the back of the form (fig. 6).

e. DA Form 11-239, Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar) will be prepared in accordance with instructions on the back of the form (fig. 7).

f. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

a. Frequency Meter AN/URM-80 is a portable instrument capable of measuring any frequency within the range of 10 to 100 megacycles (mc), with an accuracy of one part in 100,000.

b. Frequency Meter AN/URM-80 uses the heterodyne principle for determining the frequency of an unknown signal; measurement is accomplished by beating a known signal from the test instrument against the unknown signal. Check points are used to calibrate the instrument throughout its operating range.

4. Technical Characteristics

Frequency range:
- Range 1 .... 10 to 21.7 mc.
- Range 2 .... 21.7 to 46.7 mc.
- Range 3 .... 46.7 to 100 mc.

Power supply .... 115 v or 230 v ac, 50 to 1,000 cycles.

Line voltage stability required .... ±10%.

Operating temperature range .... −4° F. to +125° F.

Rf output voltage .... At least 50 μv into a 50-ohm load.

Spurious response .... 40 db down from the desired signal level.

Sensitivity .... An output of at least 2 milliwatts (mw). With an input of 10,000 microvolts (μv).

Noise level .... Residual noise is less than 16 microwatts (μw).

Audio power output .... 1 mw minimum signal-plus-noise into a nonreactive load of 600 ohms below 500 cycles with an input of 10,000 μv.

Rf input impedance .... 100 ohms.

Accuracy .... .001%.

Modulation frequency .... 800 ±300 cycles.

Power requirements .... 150 w.

Number of tubes .... 27.

5. Packaging Data

When packaged for shipment (fig. 3), the components of Frequency Meter AN/URM-80 are placed in a moisture-vaporproof container and packed in a wooden crate. The size, weight, and volume of the crates are indicated in the chart below.

Note. Items may be packaged in a manner different from that shown, depending on supply channels.

Crate No.	Width (in.)	Height (in.)	Depth (in.)	Volume (cu ft)	Unit weight (lb)
1	25	19	24.5	6.8	140

6. Table of Components

The following chart lists the overall dimensions, volume, and weight of each component of Frequency Meter AN/URM–80 (fig. 1).

Component	Reqd No.	Depth (in.)	Width (in.)	Height (in.)	Volume (cu ft)	Weight (lb)
Frequency Meter FR–5/U	1	17.2	18.9	12.3	2.32	60
Meter Case CY–1501/U	1	20.75	22.5	15.97	4.32	28
Manual for AN/URM–80	2					
Cord CG–409/U	1			4 ft. (length)		
Calibration book	1	1¼	9	12		
Running spares	1 Set					5
Total						93

Note. This table is for general information only. See appropriate publications for information pertaining to requisition of spare parts.

7. Description of Frequency Meter AN/URM–80

a. General. Frequency Meter AN/URM–80 consists of Frequency Meter FR–5/U, Meter Case CY–1501/U, and Cord CG–409/U (fig. 1).

b. Frequency Meter FR–5/U. Frequency Meter FR–5/U consists of a panel-chassis assembly and a metal dust cover. The dust cover is secured to the rear of the chassis by Dzus fasteners and to the panel by retaining screws (fig. 2). The chassis main frame is divided into two decks that hold the subassemblies. All operating controls, indicators, and the input and output jacks are mounted on the front panel. A glass window on the panel magnifies the frequency markings on the film. Frequency Meter FR–5/U is designed so that it can be mounted in a standard rack or can be placed at an angle on a table by pulling out the stand (fig. 1. Operating power required is either 115 or 230 volts alternating current (ac), 50 to 1,000 cycles per second (cps). The calibration book is in the drawer located at the lower left-hand corner of the front panel. The three sections of the book are of different colors that correspond to the colors of the three bands; namely, yellow for band 1, green for band 2, and red for band 3. The power cord and fuses are behind a hinged door at the rear of the cabinet.

c. Meter Case CY–1501/U. Meter Case CY–1501/U (fig. 1) has a detachable cover that is secured in place by eight compression catches. The running spares are contained in metal boxes fastened to the inside of the cover. Frequency Meter FR–5/U rests on four supports at the rear of the inside of the case; eight wing nuts secure the panel-chassis assembly to the case.

d. Cord CG–409/U. Cord CG–409/U is a 4-foot, rubber-covered cord with a Plug UG–88C/U on each end.

8. Running Spares

The following items are furnished:

1 tube 6X4W
1 tube OA2
1 tube OB2
1 tube 6BN6
1 tube 5749/6BA6W
1 tube 5814
2 tubes 12AT7
2 tubes 6AU6
1 tube 6AK6
1 tube 6AH6
1 tube 6C4
1 lamp GE No. 49
2 lamp GE No. 55
5 fuses 3AG–SB, 1.5 amperes
1 Crystal Unit CR–28/U, 3.6 mc

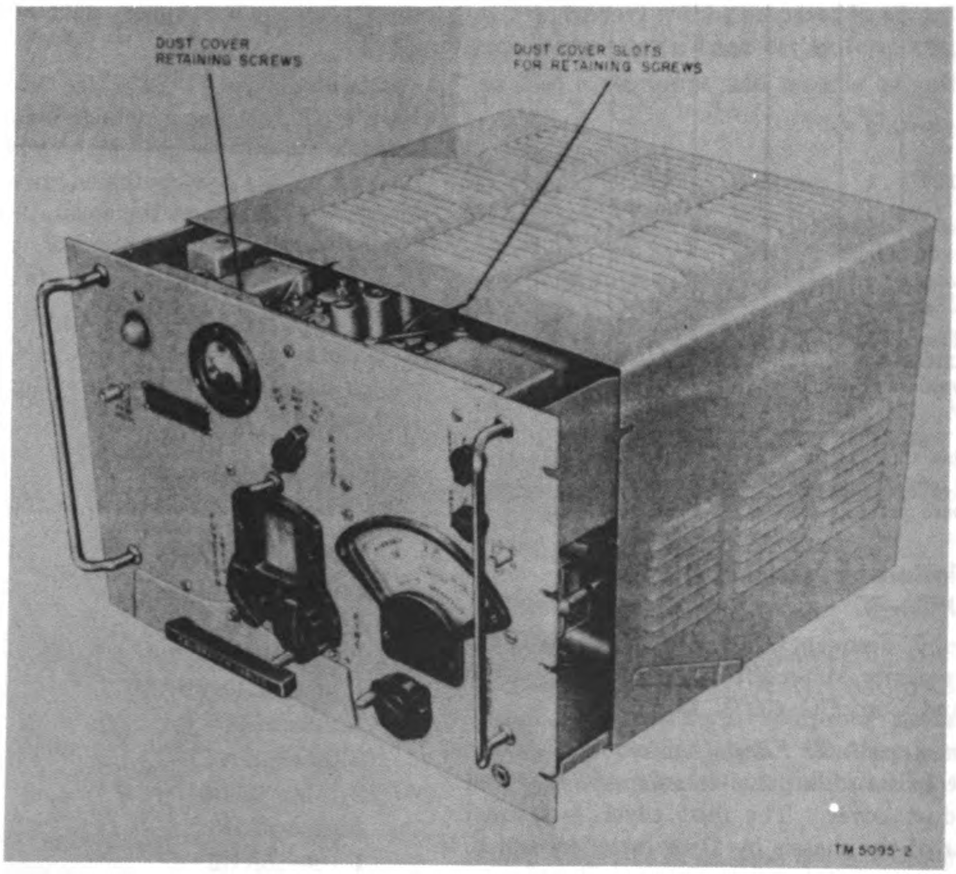


Figure 2. Frequency Meter FR–5/U, partially removed from cabinet, front view.

CHAPTER 2

INSTALLATION

9. Uncrating, Unpacking, and Checking New Equipment

Note. For used or reconditioned equipment, refer to paragraph 12.

a. General. The equipment may be shipped in packing cases or in its own carrying case. When new equipment is received, select a location where the equipment may be unpacked without exposure to the elements and that is convenient for the installation. Be sure that the equipment is not damaged. No other special unpacking and uncrating procedures are necessary for equipment shipped in its carrying case.

b. Step-by-step Instructions for Uncrating and Unpacking Shipments (fig. 3).

(1) Place the packing case as near the operating position as possible.
(2) Cut and fold back the steel straps.
(3) Remove the nails with a nail puller. Remove the top and one side of the packing case. Do not attempt to pry off the sides and top; this may damage the equipment.
(4) Set the empty crate to one side.
(5) Lift the outer carton from the moistureproof barrier, and open the carton.
(6) Lift the inner carton from the moisture-vaporproof barrier, and open the carton.
(7) Take out the corrugated fillers, felt pads, desiccant, and manuals.
(8) Remove Meter Case CY-1501/U from the inner carton.
(9) Unfasten the eight clamps on the meter case, remove the cover, and loosen the eight wing nuts so that Frequency Meter FR-5/U can be lifted from the case.
(10) Place Frequency Meter FR-5/U in the operating position.
(11) Inspect the equipment for possible damage incurred during shipment.
(12) Check the contents of the packing case against the master packing slip.

10. Placement of Equipment

Remove Frequency Meter FR-5/U from the meter case; place it near a 110- or 220-volt ac power outlet. Position the frequency meter so that its controls and the controls of the equipment under test are within easy reach.

Caution: Do not allow the power cord or radio frequency cable to drape across high-voltage lines or high-potential circuits. Severe burns or shock to the operator and damage to the equipment may result.

11. Installation of Equipment

Caution: Switch S101, located on the power supply chassis (fig. 22) of the frequency meter, must be properly set to either 110V or 220V, depending on the supply voltage, before the power cord is connected. Permanent damage to the equipment will result unless this procedure is followed.

a. This equipment is portable and can be installed or mounted anywhere a 110- or 220-volt ac power source is available. When installing the frequency meter, be sure it is rigidly supported and protected against rain or other adverse weather.

b. When installing the equipment for a permanent installation, be sure that the frequency meter is close to the test work bench for easy access to the equipment under test and to the frequency meter controls and test jacks.

c. Check fuses (fig. 29) for proper rating; then connect the power plug to the power source.

12. Service upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions in paragraph 10 for uncrating, unpacking, and checking the equipment.

b. Check the used or reconditioned equipment for tags or other indications pertaining to changes in the equipment wiring. If any changes in wiring have been made, note the change in this manual, preferably on the schematic and wiring diagrams.

c. Check the operating controls for ease of rotation. If lubrication is required, refer to the lubrication instructions in paragraphs 31 and 32.

d. Perform the installation and connection procedures given in paragraph 11.

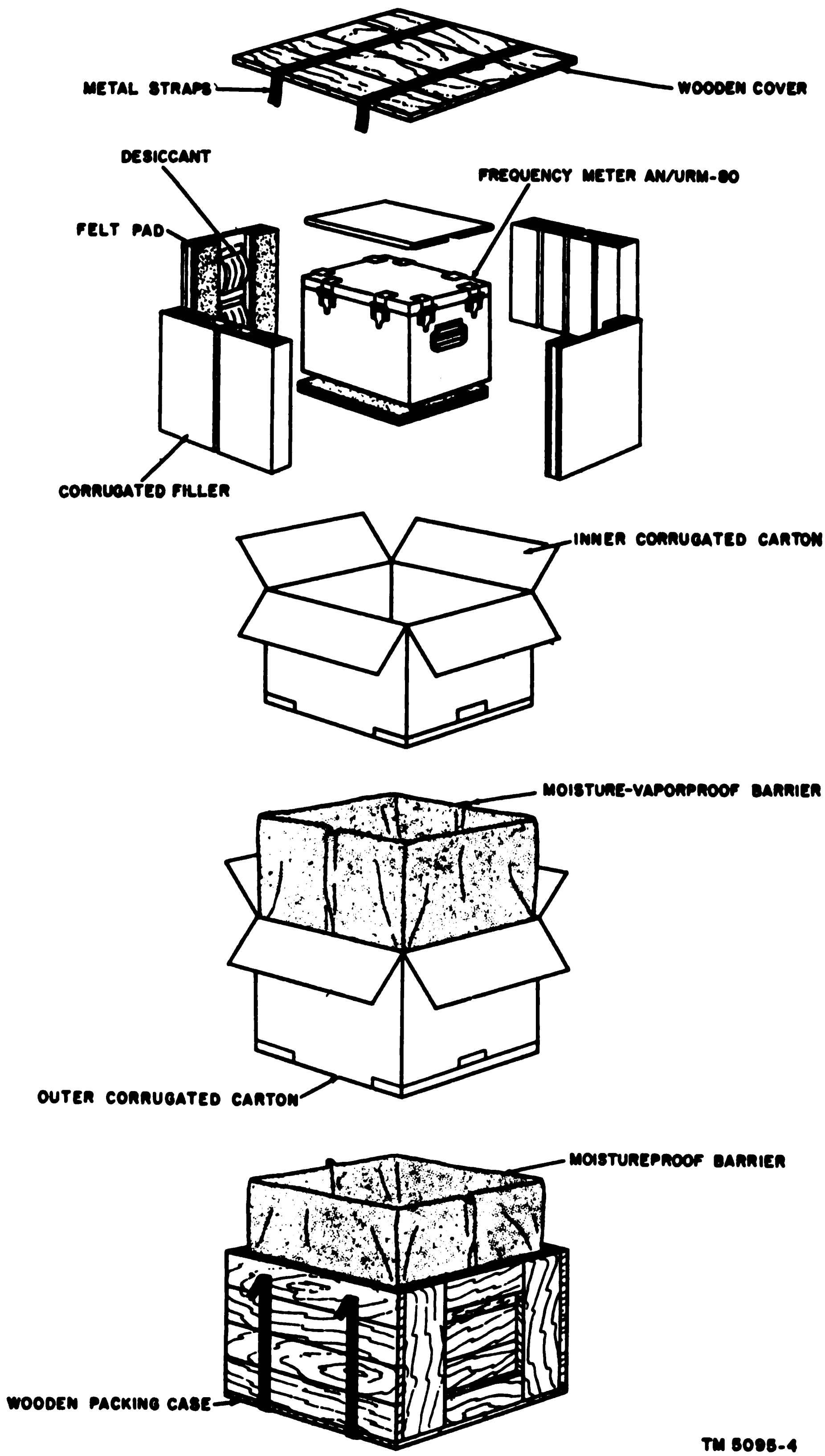


Figure 3. Typical unit packed for shipment.

CHAPTER 3

OPERATION

Section I. CONTROLS AND INSTRUMENTS

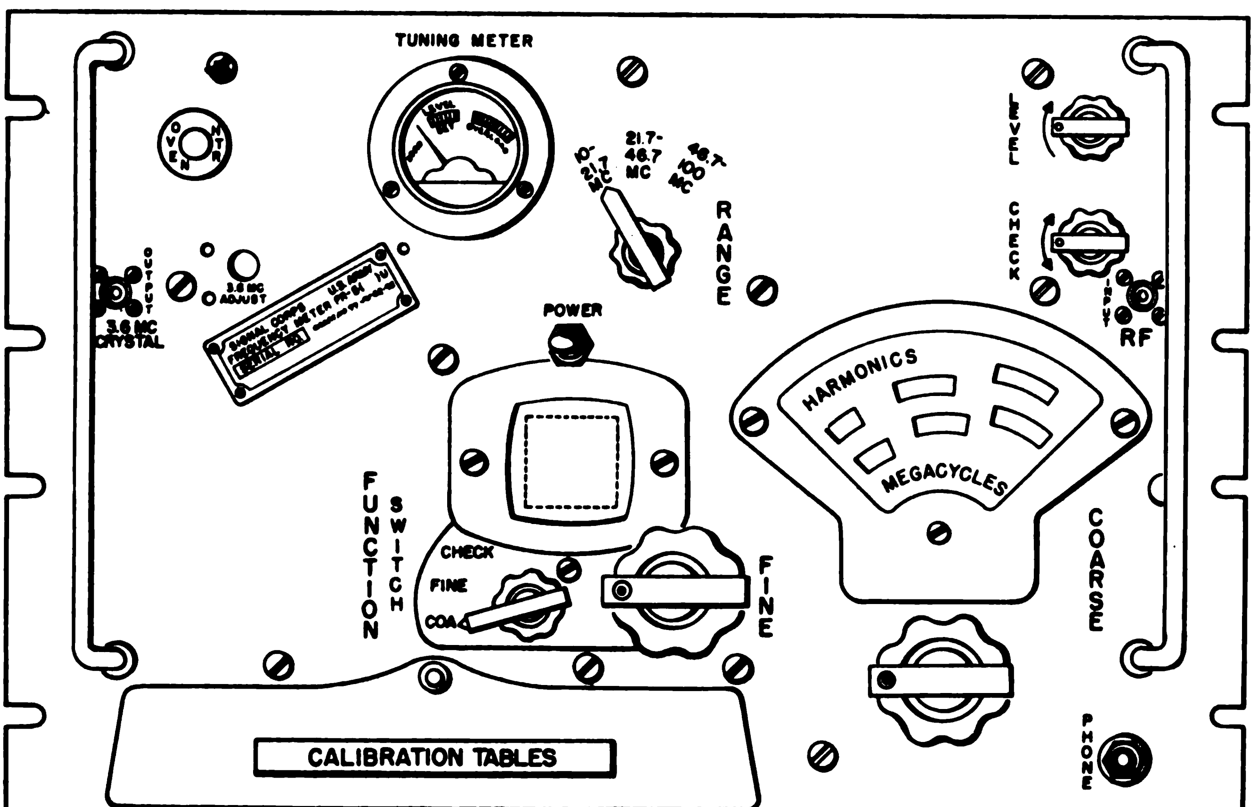
13. General

Haphazard operation or improper settings of the controls can cause damage to electronic equipment. For this reason, it is important to know the function of every control (fig. 4). The actual operation of this equipment is discussed in paragraphs 15 through 20.

14. Controls and Their Uses
(fig. 4)

The following chart lists the controls and instruments and their functions:

Control	Function
Power selection switch (on power supply chassis (fig. 22)).	Connects power transformer primaries for 110 or 220 volts.
POWER switch	In on (right) position, connects frequency meter to the ac power source.
RANGE switch	Selects circuits for operation in the following ranges: 10—21.7 MC. 21.7—46.7 MC. 46.7—100 MC.



TM 5095-6

Figure 4. Frequency Meter FR–5/U, front panel.

Control	Function
FUNCTION SWITCH	Selects circuits for operation in determining the unknown frequency. COARSE position permits operator to adjust COARSE control to approximate frequency of unknown signal. FINE position permits operator to adjust FINE control for precise measurement of unknown frequency. CHECK position permits operator to calibrate interpolation oscillator.
COARSE tuning control	Tunes rf tuner circuits to the approximate frequency under measurement and moves the proper numbered rectangle in the HARMONICS window.
FINE tuning control	Tunes the interpolation oscillator and the band-pass amplifier, and at the same time, drives the film mechanism, which indicates the basic frequency.
CHECK control	Calibrates the interpolation oscillator by zero-beating it against the crystal oscillator, as indicated on the TUNING METER.
LEVEL control	Enables the operator to control the rf input level to the detector, as indicated on the front panel meter.
3.6 MC ADJUST (located under nomenclature plate)	Tunes the crystal oscillator when its output is being monitored from from the 3.6 MC CRYSTAL OUTPUT jack.
TUNING METER	Provides visual indication of a zero beat, and also indicates the output level in the COARSE and FINE settings of the FUNCTION SWITCH.
COARSE tuning dial	Is divided into three sectors, chosen by the setting of the RANGE switch. It indicates the harmonic of the standard basic frequency selected by the COARSE control and also indicates the approximate frequency of the unknown rf input.
3.6 MC CRYSTAL OUTPUT	Test point for crystal oscillator.
OVEN HTR indicating lamp	Indication that the crystal oven heater is operating.
PHONE jack	Enables operator to monitor measurements by plugging in a headset.
RF INPUT jack	Provides a connecting point for the signal under measurement.

Section II. OPERATION UNDER USUAL CONDITIONS

15. Starting Procedure

Perform the starting procedure given below before using the operating procedure described in paragraph 18.

Caution: Switch S101, located on the power supply chassis (fig. 22), must be set to either 110V or 220V, depending on the supply voltage, before the power cord is connected. Permanent damage to the equipment may result unless this procedure is followed.

a. Preliminary. Insert the headphone plug into the PHONE jack. Plug in power cord. Set the front panel controls (fig. 4) as follows:

Control	Position
POWER switch	Off
FUNCTION SWITCH	COARSE
RANGE switch	Any
COARSE tuning control	Any
FINE tuning control	Any
LEVEL control	Midposition
CHECK control	Any

b. Starting (fig. 4).

(1) Couple the unknown signal from the equipment under test to the RF INPUT connector; use Cord CG-409/U.

(2) Set the POWER switch to the right (on) and allow a minimum of 20 minutes' warm-up time so that the crystal oven can reach the proper operating temperature. The

OVEN HTR lamp will indicate proper warm-up by cycling on and off every few seconds.

16. Operating Procedure for Measurement of Unknown Frequency

a. *Coarse Tuning* (fig. 4).

(1) Turn the RANGE switch to the setting that includes the unknown frequency within its limits. If the approximate frequency is not known, set the RANGE switch to the lowest frequency band.

(2) With the LEVEL control fully clockwise and the FUNCTION SWITCH set at COARSE, rotate the COARSE tuning control until an audio tone is heard in the headphones. If the approximate frequency is not known, it may be necessary to switch bands to locate this tone. The approximate frequency in megacycles will be shown in the illuminated MEGACYCLES window of the COARSE tuning dial.

(3) Turn the LEVEL control until the needle on the TUNING METER is in the green LEVEL SET area. Increase the meter reading by carefully turning the COARSE control. Readjust the LEVEL control, if necessary, to keep the TUNING METER needle in the green area and again increase the meter reading by turning the COARSE knob. Do not touch the COARSE control during the remainder of the measurement.

b. *Fine Tuning.*

(1) Turn the FUNCTION SWITCH to FINE and rotate the FINE tuning control until a loud low-frequency audio beat note is heard in the headphones; then tune to zero beat (no sound).

(2) Be sure that the hairline in the illuminated HARMONICS window of the COARSE tuning dial falls on a numbered black rectangle. If not, rotate the FINE tuning control until a beat is found for which the hairline does fall on a numbered black rectangle.

Calibration Check.

(1) Turn the FUNCTION SWITCH to CHECK.

(2) Rotate the FINE tuning control until the nearest black diamond-shaped mark is lined up with the hairline in the FINE tuning window under CH'K (arrows on the film in the window point in the direction of the diamond). As this diamond-shaped check point is approached, a tone will be heard. Carefully adjust the FINE knob until this tone goes to zero beat (zero sound). As zero beat is approached, the TUNING METER needle will begin to oscillate. Zero beat is indicated on the meter when the needle rests at ZERO.

d. *Final Tuning.* Return the FUNCTION SWITCH to FINE and again rotate the FINE tuning control until the loud beat note is heard in the headphones. Carefully adjust the FINE tuning control until the tone can no longer be heard in the headphones and the TUNING METER needle goes to ZERO.

Note. If the signal being measured is not sufficiently stable in frequency, an estimate of zero beat must be made.

e. *Determination of Frequency.*

(1) Turn to the section of the CALIBRATION TABLES (fig. 5) that is the same color as the illuminated portion of the COARSE tuning dial.

(2) Turn to the page number indicated under PG (page) in the fine tuning window.

(3) Read the BASIC FREQ. in the FINE tuning window and locate this number in the column of the CALIBRATION TABLES headed BASIC FREQ. (fig. 5).

(4) Read on the COARSE tuning dial the harmonic to be used and locate it in the HARMONICS column in the tables.

(5) At the intersection of the line containing the BASIC FREQ. and the HARMONICS column, read the frequency. This is the frequency of the signal being measured.

17. Stopping Procedure
(fig. 4)

a. Turn the POWER switch to off.

b. If no further frequency measurements of the source are to be made, disconnect the rf input cable.

18. Operating Procedure for Setting to Desired Frequency
(fig. 4)

a. *Determination of Dial Settings.*

(1) Set the RANGE switch to the band that includes the desired frequency.

38

BASIC FREQ.	78	80	82	84	86	88	90	92	94	96	100	104	108
	HARMONICS												
427700	33.3606	34.2160	35.0714	35.9268	36.7822	37.6376	38.4930	39.3484	40.2038	41.0592	42.7700	44.4808	46.1916
703	.3608	.2162	.0716	.9271	.7825	.6379	.4933	.3487	.2041	.0595	.7703	.4811	.1919
706	.3611	.2165	.0719	.9273	.7827	.6381	.4935	.3490	.2044	.0598	.7706	.4814	.1922
709	.3613	.2167	.0721	.9276	.7830	.6384	.4938	.3492	.2046	.0601	.7709	.4817	.1926
712	.3615	.2170	.0724	.9278	.7832	.6387	.4941	.3495	.2049	.0604	.7712	.4820	.1929
427715	33.3618	34.2172	35.0726	35.9281	36.7835	37.6389	38.4944	39.3498	40.2052	41.0606	42.7715	44.4824	46.1932
718	.3620	.2174	.0729	.9283	.7837	.6392	.4946	.3501	.2055	.0609	.7718	.4827	.1935
721	.3622	.2177	.0731	.9286	.7840	.6394	.4949	.3503	.2058	.0612	.7721	.4830	.1939
724	.3625	.2179	.0734	.9288	.7843	.6397	.4952	.3506	.2061	.0615	.7724	.4833	.1942
727	.3627	.2182	.0736	.9291	.7845	.6400	.4954	.3509	.2063	.0618	.7727	.4836	.1945
427730	33.3629	34.2184	35.0739	35.9293	36.7848	37.6402	38.4957	39.3512	40.2066	41.0621	42.7730	44.4839	46.1948
733	.3632	.2186	.0741	.9296	.7850	.6405	.4960	.3514	.2069	.0624	.7733	.4842	.1952
736	.3634	.2189	.0744	.9298	.7853	.6408	.4962	.3517	.2072	.0627	.7736	.4845	.1955
739	.3636	.2191	.0746	.9301	.7856	.6410	.4965	.3520	.2075	.0629	.7739	.4849	.1958
742	.3639	.2194	.0748	.9303	.7858	.6413	.4968	.3523	.2077	.0632	.7742	.4852	.1961
427745	33.3641	34.2196	35.0751	35.9306	36.7861	37.6416	38.4971	39.3525	40.2080	[illegible]	[illegible]		
748	.3643	.2198	.0753	.9308	.7863	.6418	.4973	[illegible]					
751	.3646	.2201	.0756	.9311	[illegible]								
754	.3648	[illegible]	[illegible]										
[illegible]													
											.7982	.5101	.2221
					[illegible]	37.6627	38.5187	39.3746	40.2306	41.0866	42.7985	44.5104	46.2224
		[illegible]	[illegible]	.9510	.8070	.6629	.5189	.3749	.2309	.0868	.7988	.5108	.2227
...	.3833	.2393	.0953	.9512	.8072	.6632	.5192	.3752	.2312	.0871	.7991	.5111	.2230
994	.3835	.2395	.0955	.9515	.8075	.6635	.5195	.3754	.2314	.0874	.7994	.5114	.2234
997	.3838	.2398	.0958	.9517	.8077	.6637	.5197	.3757	.2317	.0877	.7997	.5117	.2237
428000	33.3840	34.2400	35.0960	35.9520	36.8080	37.6640	38.5200	39.3760	40.2320	41.0880	42.8000	44.5120	46.2240
R													

MEGACYCLES PER SECOND

Figure 6. Frequency Meter FR–5/U calibration tables, sample page.

(2) Turn to the section of the CALIBRATION TABLES that is the same color as the illuminated portion of the COARSE tuning dial. Determine from the first frequency reading in each HARMONICS column, the harmonic that contains the desired frequency.

(3) On the same line as the frequency, note the number in the column headed BASIC FREQ.

(4) Rotate the FINE tuning knob until this BASIC FREQ. appears in the FINE tuning window.

b. Calibration Check.

(1) Turn the FUNCTION SWITCH to CHECK.

(2) While looking into the fine tuning window (above the FINE tuning control), rotate the FINE tuning knob until the nearest black diamond-shaped mark is lined up with the hairline on the window under CH'K (arrows on the film in the window point in the direction of the diamond). As this diamond-shaped check point is approached, a tone will be heard. Carefully adjust the CHECK knob until this tone goes to zero beat.

c. Setting to a Given Frequency.

(1) Return the FUNCTION SWITCH to FINE and reset the film in the FINE tuning window to the BASIC FREQ. indicated in *a*(4) above.

(2) Rotate the COARSE tuning control until the harmonic number found in *a*(2) above (number at top of column used) is under the hairline in the iluminated HARMONIC window of the COARSE tuning dial.

(3) The frequency meter is now tuned to the desired frequency and may be used as a signal generator as well as a frequency meter. Amplitude of the output signal can be varied by the LEVEL control.

19. Checking Transmitter Frequency

a. Frequency Meter FR–5/U can be used to check the carrier frequency of a transmitter operating in the 10-mc to 100-mc range. This procedure will determine to an accuracy of .001 per cent whether the transmitter is operating within its allowable frequency tolerances. Measurement may be made by following the instructions in paragraphs 15 and 16.

b. If the above procedure reveals that the transmitter is off frequency, Frequency Meter FR–5/U may be used as a frequency standard to retune the transmitter by following the instructions in paragraphs 15 and 18. When the frequency meter is set to the desired frequency, tune the transmitter according to standard procedure. As the transmitter carrier frequency approaches the frequency meter setting, a beat note will be heard in the headphones and the tuning meter needle will fluctuate. Continue tuning until a zero beat is attained. The transmitter is now operating at the desired frequency.

20. Receiver Tuning and Alinement

a. Frequency Meter FR–5/U can be used in the alinement of receivers. Remember, however, that the output level of the frequency meter is insufficient to aline a badly misalined receiver. Thus, its usefulness as a signal generator is limited to final precision alinement. The procedures in paragraph 18 should be followed for setting the frequency meter to the desired frequency.

b. If the receiver is to be tuned to a desired frequency, indication of proper tuning may be observed on the S meter on the receiver, an audio power output meter, a vacuum-tube voltmeter, headphones, or speaker. Tune the receiver to the preset frequency of Frequency Meter FR–5/U by observing the indicating device used with the receiver.

Section III. OPERATION UNDER UNUSUAL CONDITIONS

21. General

The operation of Frequency Meter FR–5/U may be difficult in regions where extreme cold, heat, humidity and moisture, sand conditions, etc., prevail. Although every precaution is taken to maintain its technical characteristics over a wide temperature and humidity range, adverse conditions may cause errors in measurements unless additional precautions are taken. Paragraphs 22, 23, and 24 outline procedures that minimize the effects of these unusual climatic conditions.

22. Operation in Arctic Climates

Subzero temperature and climatic conditions associated with cold weather affect the efficient operation of test equipment. Instructions and precautions for operation under such adverse conditions follow:

a. Handle the frequency meter carefully.

b. Keep the equipment warm and dry and, if necessary, construct an insulated box for the frequency meter. Keep the filaments of the tubes lighted constantly, unless this overtaxes the power source. To conserve heat, place a blanket over the frequency meter when it is not in use.

c. If the instrument is removed from its case for service, move it into a heated inclosure where there is no danger of a cold draft when a door is opened. If the inclosure is so constructed that this is impossible, place a blanket or some barrier between the source of the draft and the equipment.

d. When equipment that has been exposed to the cold is brought into a warm room, it will sweat until it reaches room temperature. When the equipment has reached room temperature, dry it thoroughly. This condition also arises when the equipment warms up during the day after exposure during a cold night.

23. Operation in Tropical Climates

When operated in tropical climates, test equipment may be installed in tents or huts. Ventilation is usually very poor, and the relative humidity causes condensation on the equipment whenever the temperature of the equipment becomes lower than the surrounding air. To minimize this condition, place lighted electric bulbs under the equipment or keep the POWER switch on.

24. Operation in Desert Climates

a. The main problem that arises with equipment operation in desert areas is the large amount of sand, dust, or dirt that enters the moving parts of test equipment. The ideal preventive precaution is to house the equipment in a dustproof shelter. However, such a building is seldom available and would require air conditioning. The next best precaution is to make the building in which the equipment is located as dustproof as possible with available materials. Hang wet sacking over the windows and doors, cover the inside walls with heavy paper, and secure the side walls of tents with sand to prevent their flapping in the wind.

b. Never tie power cords, signal cords, or other wiring connections to either the inside or the outside of tents. Desert areas are subject to sudden wind squalls that may jerk the connections loose or break the lines.

c. Keep the equipment as free from dust as possible. Make frequent preventive maintenance checks (par. 30). Pay particular attention to lubrication. Excessive amounts of dust, sand, or dirt that come into contact with oil and grease result in grit, which will damage the equipment.

d. A drastic fall in temperature at night often causes condensation on the equipment. To prevent this, cover it with a tarpaulin or similar material.

CHAPTER 4

ORGANIZATIONAL MAINTENANCE

Section I. ORGANIZATIONAL TOOLS AND EQUIPMENT

25. General

a. A number of tools, materials, or tool equipment kits are supplied to organizational maintenance personnel for use with the equipment.

b. The actual allowable organizational maintenance that can be performed on Frequency Meter AN/URM-80 depends to a large extent upon the existing military regulations (standing operating procedure), the existing tactical situation, and also upon the tools and other test equipment issued

26. Tools, Materials, and Test Equipment

Tools, materials, and test equipment used, but not supplied, with Frequency Meter AN/URM-80 are listed in *a*, *b*, and *c* below. The tools and materials contained in Tool Equipment TE-41 are listed in Department of the Army Supply Manual SIG 6-TE-41.

a. Tools.

1 Tool Equipment TE-41

b. Materials.

Sandpaper, #000*
Orange stick
Cheese cloth*
Solvent, Dry Cleaning (SD) (Fed. spec. No. P-S-66a).

c. Test Equipment.

Electron Tube Test Set TV-7/U.
Multimeter TS-297/U.

Section II. PREVENTIVE MAINTENANCE SERVICES

27. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order so that breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from troubleshooting and repair in that its object is to prevent certain troubles from occurring.

28. General Preventive Maintenance Techniques

a. Use No. 000 sandpaper to remove corrosion.

b. Use a clean, dry, lint-free cloth or a dry brush for cleaning.

(1) If necessary, except for electrical contacts, moisten the cloth or brush with solvent (SD); after cleaning, wipe the parts dry with a cloth. If the part cleaned is normally lubricated, relubricate in accordance with the instructions in paragraphs 31 and 32.

(2) Clean electrical contacts with a cloth moistened with carbon tetrachloride; then wipe them with a dry cloth.

Caution: Repeated contact of carbon tetrachloride with the skin or prolonged breathing of the fumes is dangerous. Make sure adequate ventilation is provided.

c. For further information on preventive maintenance techniques, refer to TB SIG 178, Preventive Maintenance Guide for Radio Communication Equipment.

29. Use of Preventive Maintenance Forms

a. The decision concerning the items on DA Forms 11-238 and 11-239 (fig. 6 and 7) that are applicable to this equipment is a tactical decision to be made in the case of first echelon maintenance by the communications officer/chief or his desig-

*Part of Tool Equipment TE-41.

OPERATOR FIRST ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT
RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE	EQUIPMENT SERIAL NO.

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; ⓧ Defect corrected.
NOTE: Strike out items not applicable.

DAILY

NO.	ITEM	CONDITION S	M	T	W	T	F	S
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT *(receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories).* PAR. 29a(1)							
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR. 9							
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR. 30a(2)							
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS. PAR. 30b							
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 30a(9)							
6	CHECK FOR NORMAL OPERATION. PAR. 15,16,17							

WEEKLY

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS. PAR. 30 a (2)		13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.	
8	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 30 a (7)		14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES. PAR. 30 a (2)	
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 30 a (8)		15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 30 a (2)	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.		16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHER-PROOFING.	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING. PAR. 30 a (8)		17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES. PAR. 30 a (8)		18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.	

19 IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.

DA FORM 1 MAY 51 11-238 REPLACES DA FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

TM 5095-8

Figure 6. DA Form 11-238.

TAGO 10144-A, Sept.

SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT
RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE	EQUIPMENT SERIAL NO.

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; ⓧ Defect corrected.
NOTE: Strike out items not applicable.

NO.	ITEM		NO.	ITEM	
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories). PAR. 30a(1)		19	ELECTRON TUBES - INSPECT FOR LOOSE ENVELOPES, CAP CONNECTORS, CRACKED SOCKETS; INSUFFICIENT SOCKET SPRING TENSION; CLEAN DUST AND DIRT CAREFULLY; CHECK EMISSION OF RECEIVER TYPE TUBES.	
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR. 9		20	INSPECT FILM CUT-OUTS FOR LOOSE PARTS, DIRT, MISALIGNMENT AND CORROSION. PAR. 30b(1)	
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR. 30a(2)		21	INSPECT FIXED CAPACITORS FOR LEAKS, BULGES, AND DISCOLORATION. PAR. 30b(2)	
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS. PAR. 30b		22	INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS; BURNED, PITTED, CORRODED CONTACTS; MISALIGNMENT OF CONTACTS AND SPRINGS; INSUFFICIENT SPRING TENSION; BINDING OF PLUNGERS AND HINGE PARTS.	
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 30a(9)		23	INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, MISALIGNMENT OF PLATES, AND LOOSE MOUNTINGS. PAR. 30b(3)	
6	CHECK FOR NORMAL OPERATION. PAR. 15,16,17		24	INSPECT RESISTORS, BUSHINGS, AND INSULATORS, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION AND MOISTURE. PAR. 30b(4)	
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS. PAR. 30a(2)		25	INSPECT TERMINALS OF LARGE FIXED CAPACITORS AND RESISTORS FOR CORROSION, DIRT AND LOOSE CONTACTS.	
8	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 30a(7)		26	CLEAN AND TIGHTEN SWITCHES, TERMINAL BLOCKS, BLOWERS, RELAY CASES, AND INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE. PAR. 30b(5)	
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 30a(8)		27	INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS, CRACKS AND BREAKS. PAR. 30b(9)	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.		28	CHECK SETTINGS OF ADJUSTABLE RELAYS.	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING. PAR. 30a(8)		29	LUBRICATE EQUIPMENT IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER. PAR. 31	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES. PAR. 30a(8)		30	INSPECT GENERATORS, AMPLIDYNES, DYNAMOTORS, FOR BRUSH WEAR, SPRING TENSION, ARCING, AND FITTING OF COMMUTATOR.	
13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.		31	CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS FOR TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS. PAR. 30b(7)	
14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES. PAR. 30a(2)		32	INSPECT TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS FOR OVERHEATING AND OIL-LEAKAGE. PAR. 30b(8)	
15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 30a(2)		33	BEFORE SHIPPING OR STORING - REMOVE BATTERIES.	
16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.		34	INSPECT CATHODE RAY TUBES FOR BURNT SCREEN SPOTS.	
17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.		35	INSPECT BATTERIES FOR SHORTS AND DEAD CELLS.	
18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.		36	INSPECT FOR LEAKING WATERPROOF GASKETS, WORN OR LOOSE PARTS.	
			37	MOISTURE AND FUNGIPROOF. PAR. 30b(9),33	
38	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.				

DA FORM 1 MAY 51 11-239 REPLACES DA FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

TM 5095-9

Figure 7. DA Form 11-239.

nated representative, and in the case of second and third echelon maintenance, by the individual making the inspection. Instructions for the use of each form appear on the reverse side of the form.

b. Circled items in figures 6 and 7 are partially or totally applicable to Frequency Meter AN/URM-80. References in the ITEM column refer to paragraphs in the text that contain required detailed or additional maintenance information.

30. Performing Preventive Maintenance

Caution: Tighten screws, bolts, and nuts carefully. Fittings tightened beyond the pressure for which they are designed will be damaged or broken.

a. Exterior Items.

(1) Check the general condition of the components of the frequency meter. The components are listed in paragraph 6.
(2) Remove dirt and moisture from the front panel, and connectors (fig. 1).
(3) Check the seating and rating of fuses F701 and F702 (fig. 29).
(4) Remove dirt and moisture from the dust cover (fig. 2).
(5) Inspect the metal surfaces of Meter Case CY-1501/U for rust and corrosion (fig. 1).
(6) Inspect cables for cuts, fraying, breaks, and kinks (fig. 1 and 29).
(7) Inspect switches, knobs, dials, and dial windows for looseness (fig. 2).
(8) Clean the name plate and OVEN HTR indicator lamp cover (fig. 4).
(9) Inspect controls for binding and scraping.
(10) Inspect TUNING METER for damaged glass or case.
(11) If deficiencies noted are not corrected during inspection, indicate action taken for correction.

b. Interior Items.

Caution: Disconnect all power before performing the following operations. Upon completion, reconnect power and check for satisfactory operation.

(1) Inspect belts for looseness and fraying.
(2) Inspect fixed capacitors for leaks, bulges, and discoloration (fig. 31 through 33).
(3) Inspect variable capacitors C303 (fig. 28) and C207 (fig. 38) for dirt and loose mounting lugs.

Caution: Do not touch or bend the plates of C207 or C303. This will result in loss of frequency calibration of the frequency meter.

(4) Inspect resistors for cracks, chipping, blisters, and discoloration (fig. 31, 33, 35, and 36 through 38).
(5) Clean and tighten all switches (fig. 33).
(6) Lubricate the dial gearing, film mechanism, and interpolation oscillator gearing in accordance with instructions in paragraph 31 and figure 8.
(7) Clean and tighten the connections and mountings on transformer T101 and chokes L101 and L102 (fig. 22).
(8) Inspect transformer T101 and chokes L102 and L102 for overheating.
(9) Check moistureproofing and fungiproofing varnish for cracks and chipping.

Section III. LUBRICATION

31. Lubrication Instructions

a. The only points to be lubricated are the gear faces (fig. 8), and then only when the film mechanism has been disassembled for repairs. Use Grease, Aircraft and Instruments (GL), for all gears that require lubrication.

b. Gasoline will not be used as a cleaning fluid for any purpose. When the frequency meter is overhauled or repairs are made, parts should be cleaned with solvent (SD).

c. Carbon tetrachloride will be used as a cleaning fluid only on electrical equipment where inflammable solvents cannot be used because of fire hazard, and on electrical contacts including plugs, jacks, and film mechanisms.

d. Do not use excessive amounts of grease and do not allow any surfaces to become greasy.

e. Be sure that lubricants and points to be lubricated are free from sand, grit, or dirt. Use solvent (SD) to clean all parts. Before lubrication, clean all surfaces to be lubricated; use a lint-free cloth dampened with solvent (SD). Keep the solvent off surrounding parts.

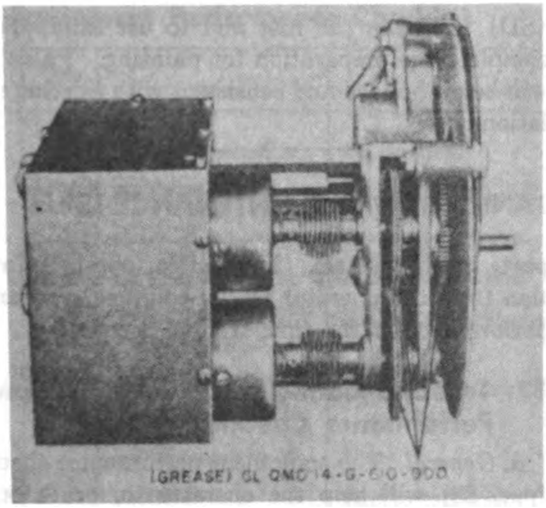


Figure 8. Typical lubrication points.

32. Lubrication under Unusual Conditions

a. Arctic Region. The lubricant used in Frequency Meter FR-5/U is satisfactory in Arctic regions. Do not over-lubricate; excess grease may impair operation of moving parts.

b. Tropical Regions. High temperatures and moisture (caused by rain, condensation, etc.) may cause normally satisfactory lubricants to flow from moving parts and other surfaces. These bearing surfaces will wear excessively, and hinges, fasteners, and other parts will be damaged or destroyed by rust and corrosion. Inspect the equipment daily and lubricate it as required to insure efficient operation.

c. Desert Regions. Dust and sand infiltration into the equipment causes grit in the lubricants and will seriously impair and damage the moving parts of the frequency meter. Hot, dry temperatures cause the lubricants to flow from the moving parts, and conditions similar to those described in *b* above will result. Use lubricants suitable for high temperatures. Inspect and clean the equipment daily.

Section IV. WEATHERPROOFING

33. Weatherproofing Procedures and Precautions

a. General. Signal Corps equipment, when operated under severe climatic conditions (tropical, arctic, and desert regions), requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extremes in temperature are harmful to most materials.

b. Tropical Maintenance. A special moistureproofing and fungiproofing treatment has been devised to provide a reasonable degree of protection. This treatment is explained in TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, and TB SIG 72, Tropical Maintenance of Ground Signal Equipment. The equipment is given the moistureproofing and fungiproofing treatment at the factory; therefore, it is necessary to use this treatment only when parts are replaced or repaired.

c. Winter Maintenance. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperatures are explained in TB SIG 66, Winter Maintenance of Signal Equipment, and TB SIG 219, Operation of Signal Equipment at Low Temperatures.

d. Desert Maintenance. Special precautions necessary to prevent equipment failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are explained in TB SIG 75, Desert Maintenance of Ground Signal Equipment.

e. Lubrication. The effects of extreme cold and heat on materials and lubricants are explained in TB SIG 69, Lubrication of Ground Signal Equipment. Observe all precautions outlined in TB SIG 69 and pay strict attention to all lubrication orders when operating equipment under conditions of extreme cold or heat. Refer to paragraph 31 for detailed instructions.

34. Rustproofing and Painting

a. When the finish on the case has been badly scarred or damaged, rust and corrosion can be prevented by touching up bared surfaces. Use No. 000 sandpaper to clean the surface down to the bare metal and to obtain a smooth finish.

Caution: Do not use steel wool. Minute particles may enter the case and cause harmful internal shorting or grounding of circuits.

b. When a touch-up job is necessary, apply paint with a small brush. Remove rust from the case by cleaning corroded metal with solvent (SD). In severe cases, it may be necessary to use solvent (SD) to soften the rust and to use sandpaper to complete the preparation for painting. Paint used will be authorized and consistent with existing regulations.

Section V. TROUBLE SHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

35. General Troubleshooting Information

a. The troubleshooting and repairs that can be performed at the organizational maintenance level (operators and repairmen) are limited in scope by the tools, test equipment, and replaceable parts issued and by the tactical situation. Accordingly, troubleshooting is based on the performance of the equipment and the use of the senses in determining such troubles as burned-out fuses, broken cords, defective tubes, cracked insulators, etc.

b. Paragraphs 36 through 38 help in locating faulty circuits and in localizing the faults to the defective stage or item.

36. Visual Inspection

a. Failure of this equipment to operate properly usually will be caused by one or more of the following:

(1) Improperly connected power cord to power source.
(2) Worn, broken, or disconnected cords or plugs.
(3) Burned-out fuses (usually indicates another fault).
(4) Wires broken because of excessive vibration.
(5) Defective tubes.
(6) Inactive crystal.

b. When failure is encountered and the cause is not immediately apparent, check as many of the items listed in *a* above as is practicable before starting a detailed examination of the component parts of the system. If possible, obtain information from the operator of the equipment regarding performance at the time trouble occurred.

37. Troubleshooting by Using Equipment Performance Checklist

a. General. The equipment performance checklist (par. 38) will help the operator to locate operational troubles within the equipment. The list gives the item checked, the conditions under which the item is checked, the normal indications and tolerances of correct operation, and the corrective measures the operator can take. *To use this list, follow the items in numerical sequence.*

b. Action or Condition. For some items, the information given in the action or condition column consists of various switch and control settings under which the item is to be checked. For other items it represents an action that must be taken to check the indication given in the normal indications column.

c. Normal Indications. The normal indications listed include the things that the operator should notice when he checks the items. If the indications are not normal, the operator or repairman should apply the recommended corrective measures.

d. Corrective Measures. In most cases, the corrective measures listed are those the operator can make without turning in the equipment for repairs. If the recommended corrective measures are beyond the operator's capabilities, a reference is made to the Field Maintenance Section.

38. Equipment Performance Checklist

	Item No.	Item	Action or condition	Normal indications	Corrective measures
PREPARATORY	1	POWER switch	Off position.		
	2	RANGE switch	Set to desired band.		
	3	CHECK control	Set to midposition.		
	4	LEVEL control	Set to midposition.		
	5	FUNCTION SWITCH	Set to COARSE position.		
	6	COARSE tuning control	Set to approximate frequency.		
	7	FINE tuning control	None.		
	8	PHONE jack	Plug in earphones.		
START	9	POWER switch	Set to on position.	One of the COARSE tuning dial maps and the film illuminating lamp are lighted. OVEN HTR lights.	Check fuses F701 and F702, ac power source, and dial lamps. Replace OVEN HTR lamp or OVEN.
EQUIPMENT PERFORMANCE	10	RF INPUT jack	Apply signal to be measured to jack.		
	11	RANGE switch	Set to proper band for unknown signal frequency.	Yellow, red, or amber lamp on the COARSE tuning dial will light depending on setting.	Check dial lamps.
	12	COARSE tuning control	Adjust to approximate frequency.	A beat note should be heard in headset as unknown frequency is approached.	RANGE switch not properly set.
	13	LEVEL control	Set for proper level.	Needle of TUNING METER should be on green LEVEL SET portion of meter face.	Refer to paragraph 53.
	14	FUNCTION switch	Set to FINE position.	Audio note in headset will disappear.	Refer to paragraph 53.
	15	FINE tuning control	Rotate control.	Film strip will rotate. Audio note will be heard as the unknown frequency is approached. Pitch of tone will decrease as zero beat is approached and increase after it is passed. Final tuning to zero beat should be done by watching the needle of front panel meter. When oscillations of needle have stopped, zero beat is attained.	Refer to paragraph 53.
	16	Film strip	Read frequency on right side of film strip in window.		

38. Equipment Performance Checklist—Continued

	Item No.	Item	Action or condition	Normal indications	Corrective measures
STOP	17	POWER switch	Set to off.	All dial lamps and indicator lamps go out.	Check switch (S702).

CHAPTER 5

THEORY

39. Block Diagram

The block diagram for Frequency Meter FR–5/U is shown in figure 9. For more detailed circuit information, refer to the schematic diagram (fig. 39).

a. Principles of Operation. In the usual method of heterodyne frequency measurement, selected harmonics of a fixed frequency standard are beat with the signal frequency to be measured to produce a beat frequency. In Frequency Meter FR–5/U, selected harmonics of a standard basic frequency are beat with the unknown frequency to be measured. The algebraic sum of the resulting beat frequency and the chosen harmonic of the standard basic frequency will equal the unknown frequency. When zero beat is reached, the standard basic frequency and the unknown frequency are identical. To zero beat any one of a variety of unknown frequencies, the standard basic frequency against which the unknown is beat must be continuously variable. Frequency Meter FR–5/U combines a frequency standard (crystal oscillator) with an interpolation oscillator to produce a variable basic frequency. A selected harmonic is matched to the frequency under measurement by zero beating them in a detector. By means of the COARSE tuning control, the rf tuner circuits are tuned close to the frequency under measurement. The COARSE tuning control rotates the dial so that a harmonic number will appear in the window. A beat note will be heard in the headset as the unknown frequency is approached. The FINE tuning control is then used to tune the interpolation oscillator producing the basic frequency from which the harmonic is derived. As the FINE control is rotated, a floating indicator is moved across the dial. When zero beat is attained, this indicator will rest upon a block whose number indicates the harmonic number. The basic frequency is indicated on the film strip. From the standard basic frequency f_s on the film strip and the harmonic number on the COARSE tuning dial, the unknown frequency f_x can now be found in the calibration tables.

b. Interpolation Oscillator.

(1) Tuning is accomplished by turning the FINE tuning control, which is linked mechanically to a variable capacitor in the tank circuit of V401A, to the film mechanism, and to a variable capacitor in the band-pass amplifier. The film strip is calibrated in terms of the basic frequency; that is, the sum of the interpolation oscillator and the crystal oscillator frequencies.

(2) The interpolation oscillator consists of oscillator V401A, which generates signals in the range of 16.6 to 34 kilocycles (kc) for addition to the output of the crystal oscillator. Buffer V401B amplifies the output of V401A, then feeds it to the balanced modulator and the crystal oscillator.

c. Crystal Oscillator. The crystal oscillator is composed of 3.6-mc crystal Y501, tuned amplifier V502, phase inverter V501, frequency dividers V503 and V504, buffer amplifier V505A, harmonic generator V506, and amplifier V505B.

(1) The oscillator circuit is composed of crystal Y501, tuned amplifier V502, and phase inverter V501. The crystal supplies a 3.6-mc signal to tuned amplifier V502. The output of V502 is applied to phase inverter V501. The output of the phase inverter is fed back to the crystal to sustain oscillations, and also to first frequency divider V503.

(2) Frequency dividers V503 and V504 each divides the crystal output by a factor of three or, together, by a factor of nine. The resultant 400-kc signal is delivered to buffer amplifier V505A, which applies the signal to the balanced modulator and to the check circuit. When the FUNCTION SWITCH is in the CHECK position, buffer amplifier V505A, a cathode follower, isolates the frequency dividers from the balanced modulator and provides an im-

pedance match to the cable feeding the balanced modulator.

(3) When the FUNCTION SWITCH is in the CHECK position, the check circuit, which consists of amplifier V505B and harmonic generator V506, is energized and is used to calibrate the interpolation oscillator at any one of its 25 check points; that is, at frequencies such as 20, 25, and 32 kc, of which 800 kc is a common harmonic. The harmonic being generated at any given instant is beat against the 800-kc second harmonic from the crystal oscillator. A trimmer in the interpolation oscillator is then tuned by the CHECK control until a zero beat indication is obtained on TUNING METER.

d. Balanced Modulator. The output of the interpolation oscillator (16.6 to 34 kc) is added to the 400-kc signal from the crystal oscillator in a balanced modulator, consisting of mixers V602 and V603, and output buffer amplifier V601. The output of the mixer stage is the sum (416.6 to 434 kc) of the two frequencies fed to the balanced modulator and is the standard basic frequency used in determining the unknown frequency. The output is fed through buffer amplifier V601 to the band-pass amplifier.

e. Band-Pass Amplifier. By setting RANGE switch S301 to the proper position, the band-pass amplifier may be operated on any one of three bands as shown in the table below. The fourth column gives the actual range of frequencies, dependent on the setting of the interpolation oscillator, that may appear in the output of the band-pass amplifier for each setting of the RANGE switch. The amplified standard, or second or fourth harmonic of the standard, is delivered to the first, second, or third band circuit, respectively, of the rf tuner.

RANGE switch	Band (colors refer to COARSE) tuning dial	Harmonic of standard produced in balanced modulator	Range of harmonic of standard (kc)	Stages used
10–21.7 MC	1 (yellow)	1st (fundamental).	416.6–434	V301 and V302
21.7–46.7 MC	2 (green)	2nd	833.2–868	V301 and V304
46.7–100 MC	3 (red)	4th	1666.4–1736	V301 and V306

f. Rf Tuner. The rf tuner resonant frequency is also controlled by the RANGE switch for operation on any one of the three bands. Power is applied to the proper section by means of the switch. Each of the three circuits consists of a crystal diode harmonic generator, an rf amplifier, and a detector. Once the range, or band, has been selected, the circuit is tuned approximately to the input frequency with the COARSE control. To do this, the rf signal is audio modulated, and the circuit is tuned until the audio signal is most clearly detected. With the FUNCTION SWITCH in the COARSE position, the rf amplifier (V201A, V202A, or V202B) is tuned until the loudest tone is heard in the headphones. The tone is produced at the output of the detector (V201B, V203A, or V203B). With the FUNCTION SWITCH in the COARSE position, there is no input to the rf tuner from the band-pass amplifier. With the FUNCTION SWITCH in the FINE position, the standard basic frequency is reintroduced and is varied by fine-tuning the interpolation oscillator, and is beat against the rf [illegible] until a zero beat is produced; this is shown on the TUNING METER. At this point, the standard basic frequency or its second or fourth harmonic, depending on the setting of the RANGE switch, equals the unknown frequency.

g. Rf Modulator. Amplitude modulation of the rf signal is performed in this absorption-type modulator, composed of two parallel diode crystals, CR701 and CR702. Modulation is produced by an 800 ±300 cps signal from audio oscillator V105, which is located on the power supply chassis.

h. Audio Amplifier. The audio amplifier is a three-stage amplifier consisting of V106, V107, and V108B located on the power supply chassis. It amplifies the audio output of the rf tuner detectors when the FUNCTION SWITCH is in the COARSE or FINE position. It also amplifies the output of the check system when the FUNCTION SWITCH is in the CHECK position. A signal is taken from the first stage, amplified by V108A, and applied to the TUNING METER.

i. Power Supply.

(1) The power supply, located on the main frame, supplies voltage for the plates and filaments. The power transformer supplies 6.4 and 6.5 volts for the filaments. A full-wave rectifier (V101 and V102 in parallel) supplies +240 volts direct current (dc) to some circuits. Voltage regulators V103 and V104 supply 150 and 108 volts to other circuits.

(2) The audio oscillator, located on the power supply chassis, uses a 6BN6 gated-beam tube. The oscillator produces an 800 ±300 cps signal for modulating the rf signal (*g* above) during operation in the COARSE position.

40. Interpolation Oscillator

The interpolation oscillator is a highly stable oscillator whose frequency may be varied from 16.6 to 34 kilocycles. It consists of a modified Colpitts oscillator V401A, known as a Clapp oscillator, and buffer-amplifier V401B. Its output is fed to the balanced modulator.

a. Oscillator (B, fig. 10).

(1) The circuit of oscillator V401A is similar to a Colpitts oscillator except that a series LC circuit replaces the conventional parallel-tuned circuit. This is similar to a crystal oscillator using the Colpitts method of feedback. The series-resonant circuit has across it a voltage divider network consisting of C405 and C406. The grid is connected to one end of this network and the plate to the other end. The ratio of the voltage developed across the capacitors in the divider network will determine the amplitude of the feedback voltage. Thus, a voltage of the proper phase and amplitude necessary to sustain oscillations is fed to the grid of the tube. In this circuit, the capacitance values of C405 and C406 are very much larger than tuning capacitor C_0; therefore, the tube internal capacitances have very little loading effect on the resonant frequency of the series-tuned circuit. In effect, the resonant circuit is isolated from the tube variables by voltage divider network C405 and C406, resulting in a high degree of frequency stability.

(2) In the actual circuit, shown in A, figure 10, capacitors C410, C401, C402, and C403 are the ones represented by C_0 in the equivalent circuit. The tank circuit is composed of these capacitors and inductor L401. Capacitors C405 and C406 form the voltage divider across the series resonant circuit. The voltage developed across C406 is applied to the grid of V401A. This voltage is of the proper phase and amplitude necessary to sustain oscillations. Grid leak bias is provided by capacitor C407 and resistor R402. The high resistance value of resistor R402 minimizes grid current, which further reduces the loading effect caused by the tube. The feedback signal is applied to the grid through capacitor C407. The rf choke in the cathode leg provides the cathode dc return path and increases stability. Resistor R405 and capacitor C409A form the plate decoupling network. During operation, the oscillator is tuned by the FINE control, when the FUNCTION SWITCH is in the FINE position. The FINE control is geared to C403 and to the film strip. When the FUNCTION SWITCH is in the CHECK position, the oscillator is calibrated at its nearest check point by the CHECK control, which is coupled to C402. Capacitor C402 and the film mechanism are coupled by a special timing belt. This belt system is used because of its simplicity and positive action. The Clapp oscillator is highly stable in spite of changes in temperature and power supply voltage variations. The output is taken from the junction of L401 and the paralleled tuning capacitors and applied through C404 and isolating resistor R401 to the grid of buffer V401B.

b. Buffer-Amplifier. Amplifier V401B isolates the oscillator against fluctuations and variations caused by circuit loading. The plate of the buffer is bypassed to ground by C409B. Resistor R403 provides the grid return. The output signal is developed across cathode resistor R404 and applied through C408 to the balanced modulator and to V505B in the check circuit.

41. Crystal Oscillator

The crystal oscillator chassis is composed of a two-stage, 3.6-mc, crystal-controlled oscillator and two regenerative frequency dividers. The dividers successively divide the oscillator output by three, thus producing a 400-kc output, which is delivered

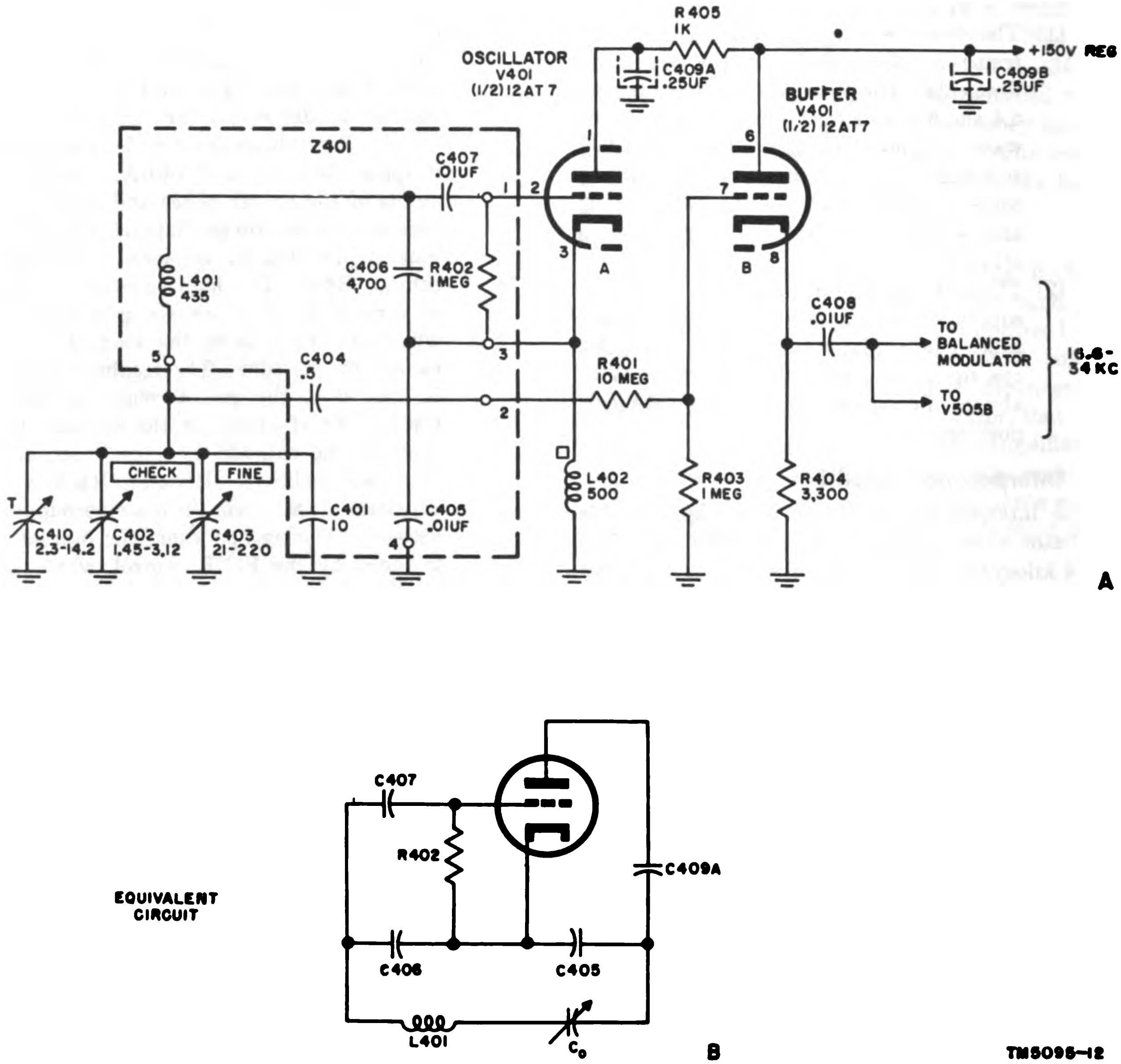


Figure 10. Interpolation oscillator, simplified schematic diagram.

to the balanced modulator. The check circuit beats the second harmonic of the 400-kc signal against harmonics of the interpolation oscillator output to produce zero beat at each interpolation oscillator check point.

a. 3.6-mc Oscillator (fig. 11).

(1) Crystal Y501 resonates at 3.6 megacycles. Oscillation is sustained by the positive feedback from the plate of phase inverter V501. Resistor R505 provides the dc return for the amplifier grid. The output of V502 is taken across the tuned plate load consisting of 3.6 mc ADJUST capacitors C503 and C504, capacitor C505, and inductor L501, and is coupled through C508 to the control grid of V501. Resistor R529 lowers the Q of the tank circuit, and prevents spurious oscillations. Resistor R503 and capacitor C506 form a plate decoupling network; R504 is the screen dropping resistor and C502 is the screen bypass capacitor. Cathode bias is developed across R502, and C501 bypasses rf around R502.

(2) The output of V502 is applied to the control grid (pin 1) of V501 through C508.

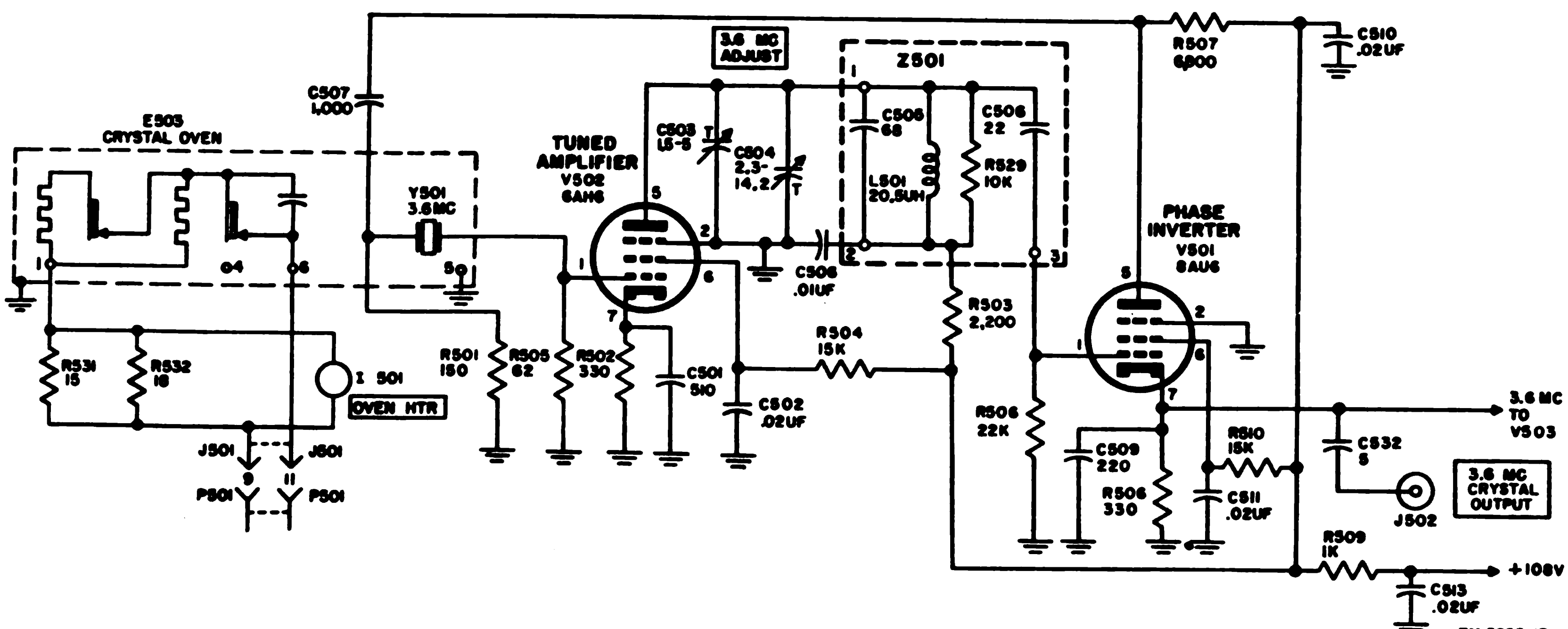


Figure 11. Crystal oscillator, 3.6-mc oscillator, simplified schematic diagram.

The input voltage is developed across R506. Cathode bias for V501 is developed across R508. The reactance of C509 is very high to the 3.6-mc signal output but presents a low reactance to harmonics; this prevents them from appearing in the output. The decoupling network in the 108-volt supply is formed by C513, R509, and C510. Screen-grid voltage for the phase inverter is supplied through dropping resistor R510. The rf is bypassed around R510 by C511.

(3) The signal developed across plate load R507 is coupled back to the crystal through C507. The amplitude of the voltage across R505 in the grid circuit of V502 is sufficient and in the correct phase because of normal tube action, to sustain oscillations in the crystal. The signal is made available at 3.6 MC CRYSTAL OUTPUT jack J502 through C532.

b. First Frequency Divider (fig. 12). The first frequency divider, V503, is of the regenerative type, in which the A section of the tube is the mixer and the B section is the doubler. The plate circuit of the A section is tuned to 1.2 megacycles and that of the B section to 2.4 megacycles. The 3.6-megacycle signal from the crystal oscillator is coupled through C512 and across L503 to the grid of V503A. Because of the initial surge, the 3.6-megacycle input signal will shock excite the plate tank circuit which is tuned to 1.2 megacycles. The plate load circuit consists of one winding of transformer T501 and capacitors C520 and C514. The 1.2-megacycle signal is coupled through C518 to V503B where amplification and harmonic generation take place. Resistor R514 is the grid return resistor. Energy is developed at the second harmonic (2.4 megacycles) across the plate tank circuit of V503B, which consists of the other winding of T501 and C515. This signal is coupled through C516 back to the grid of V503A. Inductor L503 provides the dc grid return and isolates the grid from ground. Cathode bias is developed by R512 and rf is bypassed around it by C517. The output of V503A will contain the difference frequency between the 3.6-megacycle and 2.4-megacycle signals that are impressed on its grid. The resultant 1.2-megacycle signal will now be strong enough to maintain the flywheel effect in the plate tank circuit. This amplified signal appears across the tuned circuit and is coupled through C521 to the grid (pin 2) of V504. Plate voltage for V503A is supplied from voltage divider R511 and R513. The junction of these two resistors is bypassed to ground by capacitor C542. Resistor R530 and capacitor C519 form a decoupling circuit that isolates the plate circuit of V503B from the power supply.

c. Second Frequency Divider (fig. 12). Second frequency divider, V504, is also of the regenerative type, in which the A section is the converter and the B section is the doubler. The plate circuit of the A section is tuned to 400 kilocycles and that of the B section to 800 kilocycles. Starting transients will shock excite the A-section tuned circuit which begins the regenerative action. The 400-kilocycle signal developed in the plate tank is amplified and doubled in the B-section circuit and is beat against the 1.2-megacycle signal in the A section. As in the first frequency divider, the starting surge will excite the plate tank, causing it to oscillate. The oscillations will be sustained by the beating of the doubled frequency (800 kilocycles) with the incoming 1.2-megacycle signal, and the resultant signal is fed to the 400-kc tank circuit of V504A. The starting 400-kc signal is developed across the plate load circuit consisting of one winding of T502, C522, and C523. The 400-kilocycle signal is coupled through C526 and R519 and applied to the grid of V504B, where amplification and harmonic generation take place. Energy is developed at the second harmonic (800 kc) in the plate circuit of V504B which consists of the other winding of T502 and C528, tuned to 800 kilocycles. The 800-kilocycle signal is coupled through C525 back to the grid of V504A. Resistor R515 provides the dc grid return for V504A. Cathode bias for V504A is developed by R512; the rf is bypassed around R512 by C517. Resistors R516 and R518 form a voltage divider network that supplies plate voltage for V504A and V504B. The signals are bypassed around R518 by C524. The output is the 400-kilocycle difference frequency between the 1.2-megacycle and 800-kilocycle signals. This 400-kilocycle signal is coupled through C529 to the grid of cathode follower V505A.

d. Buffer-Amplifier (fig. 13). Buffer-amplifier V505 isolates the frequency dividers from the balanced modulator and matches the output impedance to that of the cable to the balanced modulator. The buffer-amplifier operates as a cathode follower. The grid-tuned circuit consists of T503A and C531. Resistor R520 is across the tuned circuit

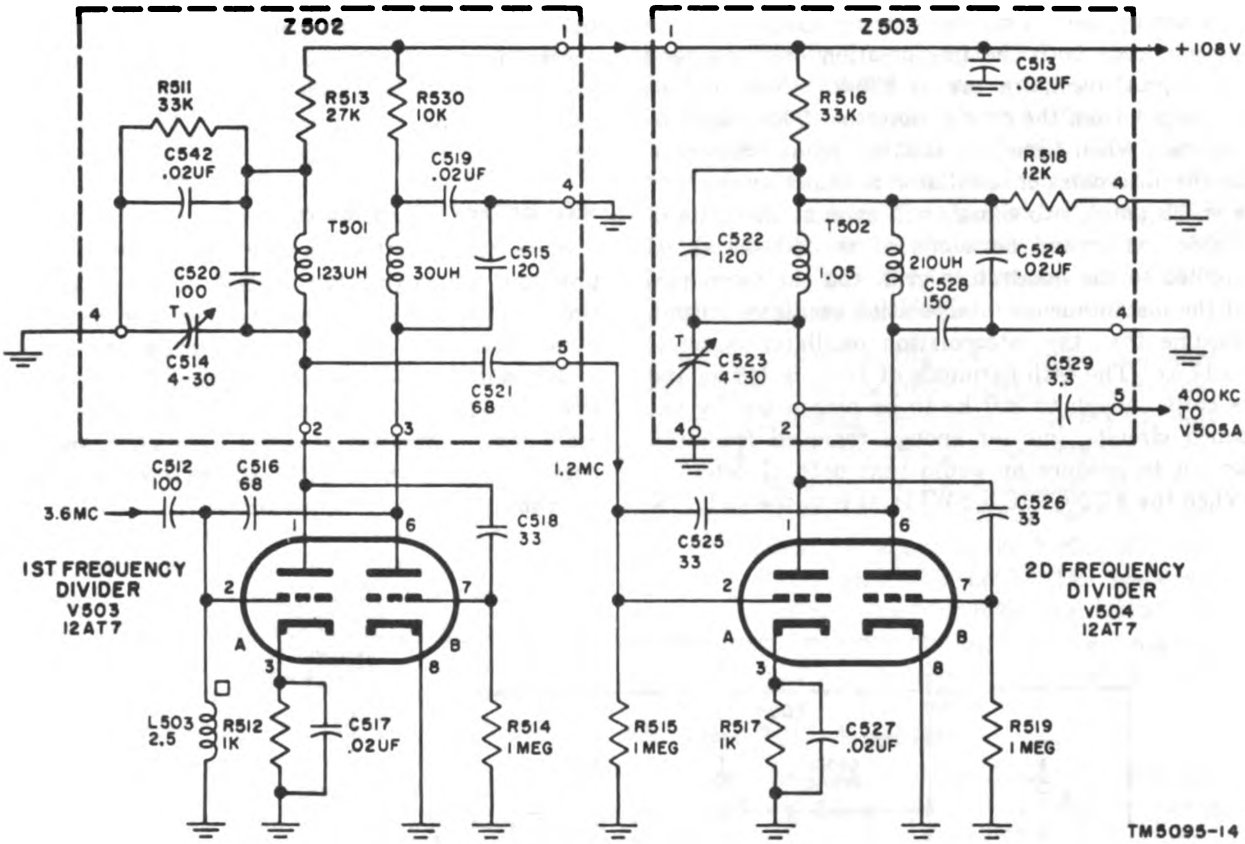


Figure 12. Crystal oscillator frequency dividers, simplified schematic diagram.

and broadens the frequency response. The signal is applied to the grid of V505A through coupling capacitor C529. The output of the stage is taken from cathode resistor R522. Plate voltage for the buffer amplifier is supplied through resistor R521. Resistor R521 and C530 form a decoupling network.

e. Check Circuit (fig. 13). The check circuit, which consists of V505B and V506, is energized when the FUNCTION SWITCH is in the CHECK position and is used to calibrate the interpolation oscillator in terms of the 400-kc crystal oscillator output. The 400-kc output is taken from cathode resistor R522 of buffer amplifier V505A and applied to the quadrature grid (pin 6) of V506, a gated-beam 6BN6 tube. The output of the interpolation oscillator is coupled through C537 to the grid of amplifier V505B. Grid-leak bias is developed by R527 and C537. The amplified output developed across plate load resistor R526 is coupled through C533 and R523 to the signal grid (pin 2) of V506. Voltage to the accelerator grid (pin 5) is supplied through dropping resistor R528 which is bypassed by C535.

f. Plate and Accelerator Grid Current. The plate and accelerator grid current flow produces a bias of +3.5 volts (near the cutoff valve) across cathode biasing network R524 and C540. The tube will conduct only during the positive half-cycles of the signal input and then only on the extremely steep portion of the grid voltage-plate current curve. This results in strong harmonic generation. The check points are those frequencies between 16.6 and 34 kilocycles, which are submultiples of 800 kilocycles. Therefore, when the interpolation oscillator is tuned to a check point, it will produce an 800-kc harmonic in the plate circuit of V506. At the same time, the 400-kc signal from V505A is applied to the quadrature grid. This grid is at an average potential of about +3 volts, placing operation on a nonlinear portion of the plate current quadrature-grid voltage curve. This results in strong harmonic generation. The plate circuit is tuned by L502 and C534 to 800 kilocycles.

g. The output of V506 is coupled through C541 to the tuned circuit consisting of C536 and T503B. The signal voltages developed across the tuned circuit are applied to crystal detector CR501. If the signals from both the interpolation oscillator and the crystal oscillator are at 800-kc, there will be no output from the crystal detector. This would be the case when tuned to a check point. However, as the interpolation oscillator is tuned away from a check point, two signals will exist at the plate of V506: the second harmonic of the 400-kc signal applied to the quadrature grid, and the harmonics of the instantaneous interpolation oscillator output. Assume that the interpolation oscillator is tuned to 17 kc. The 44th harmonic of 17 kc is 748 kc and is close enough to 800 kc to be picked out by the tuned circuits, but far enough removed from 800 kc not to produce an audio beat note, if detected. When the FUNCTION SWITCH is in the CHECK position, both signals would be applied to the crystal detector CR501, and the difference frequency produced would be applied through C539 to V108. Capacitor C538 bypasses the higher frequencies around load resistor R525.

42. Balanced Modulator

Since the variable standard basic frequency is produced by mixing the signals of the interpolation and crystal oscillators, frequency components other than the desired sum frequency will appear in the output. Elimination of some of the undesired frequencies is accomplished by a balanced modulator consisting of V602 and V603 and the buffer amplifier V601. The modulator output equals the sum of the two frequencies.

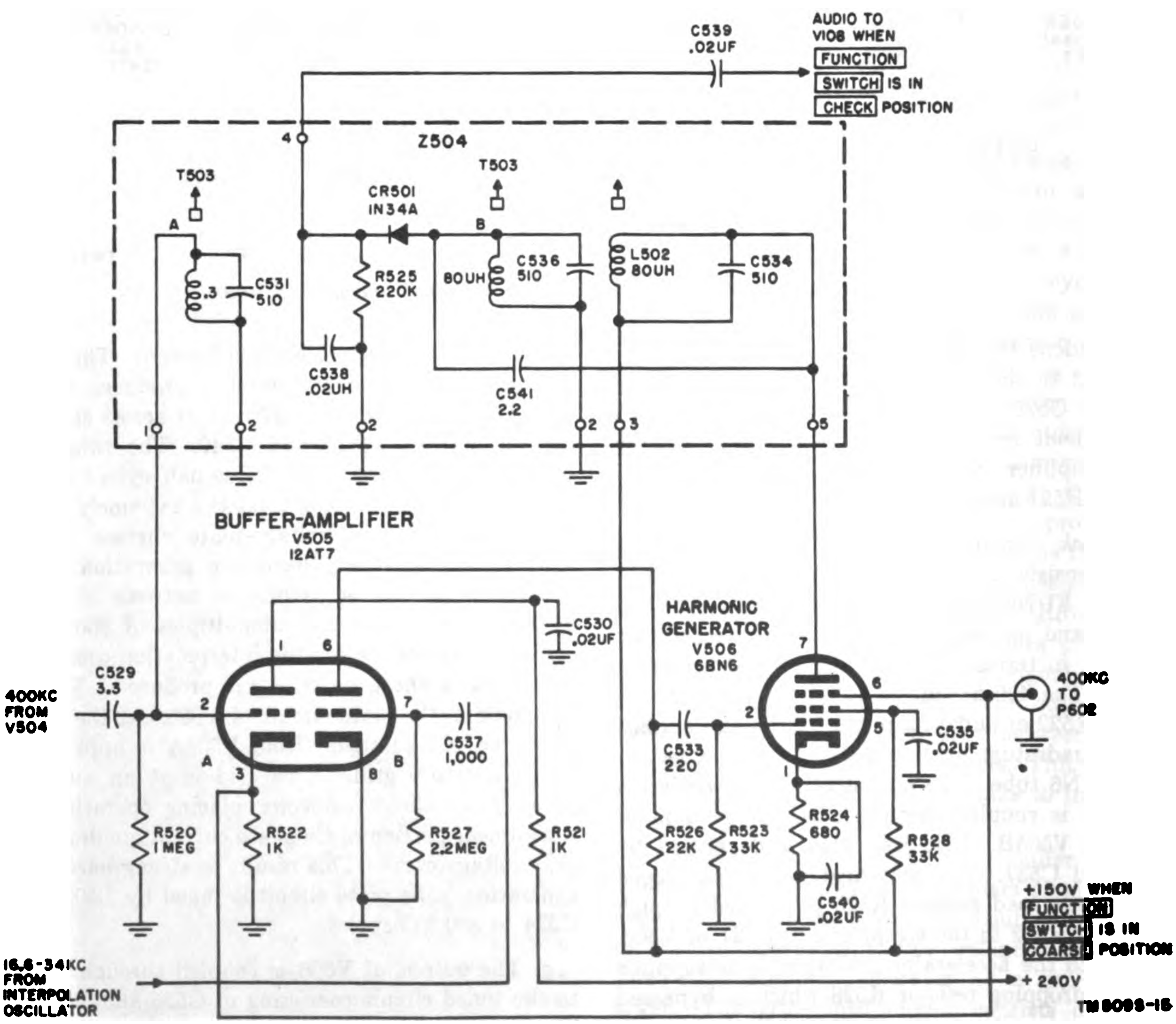


Figure 13. Crystal oscillator, output and check circuits, simplified schematic diagram.

a. Modulator Circuit (fig. 14). The 400-kc output of the buffer amplifier is applied to the primary of input transformer T601, which, with capacitors C601 and C602, forms a tuned circuit. The primary and secondary are tuned separately. Equal amplitude, but out-of-phase signals, are developed across the B and C secondaries; capacitor C605 resonates the entire secondary circuit at 400 kilocycles. Capacitors C603 and C604 bypass the center tap of T601; therefore, signals of equal amplitude but opposite phase are applied to the grids of V602 and V603 from the 400-kc crystal oscillator. The plates of the tubes, however, are operated in push-push. This means that while the grids are being driven on alternate half-cycles (by being connected to opposite ends of the transformer) the plates are operating together because they are tied together. A common plate load, in this case the tuned circuit consisting of resistor R605, transformer T603, and capacitor C609, is used. The signal at the plate of one tube is always being bucked by the signal from the opposite tube; this effectively cancels out the fundamental frequency. The variable output signal of the interpolation oscillator is also applied to the grids of V602 and V603 equal in amplitude but opposite in phase through T602. If applied alone, this signal will have the same effect as the 400-kc signal. However, this signal is a low level signal and is used to modulate the 400-kc input signal. The two signals are mixed within the tubes and the sum and difference frequencies will appear in the output. The plate tank circuit, C609 and the primary of T603, is tuned to the sum frequency and allows only the sum frequency of the interpolation oscillator and the 400-kc signal to pass to the next stage. The primary of T603, the plate load, has its response broadened by R605. Some of the 400-kc input signal may be amplified and passed along with the desired signal. However, the stages following in the band-pass amplifier eliminate any undesired 400-kc signal remaining from the balanced modulator. The harmonics of 400 kilocycles are very high in comparison with the tuned circut output of V602 and V603 and are filtered easily. In the 16.6- to 34-kc signal, the second order harmonics would fall within the range of the tuned output, so special steps are taken to minimise their effect. One of these is to use this signal at a low level to modulate the high-level 400-kc signal; therefore, any portion of this signal that does pass through the amplifiers is extremely weak. The outputs of the two are made equal by balance control R603. This control establishes a balance by varying the screen-grid voltage applied to the tubes through dropping resistors R602 and R604. The screen-grid signals are bypassed to ground by C607 and C608. Cathode bias is developed by R601 and C606. The signal developed in the primary of T603 is coupled to the secondary and applied to the grid of buffer amplifier V601 an isolation cathode follower. The secondary is resonated by C611 and the response of the tank circuit is broadened by R606.

b. Buffer Amplifier (fig. 14). Buffer amplifier V601 isolates the modulator circuit from fluctuations in the following circuits and matches the output impedance to the cable that delivers the standard basic frequency to the band-pass amplifier. The output is taken from cathode resistor R608. Plate and screen voltages for the buffer amplifier are supplied through choke L601. The plate decoupling circuit is formed by R607 and C612. Additional plate supply filtering for the balanced modulator plate and screens is provided by C610.

43. Band-Pass Amplifier

The band-pass amplifier produces the amplified standard basic frequency or its second or fourth harmonic, depending on the RANGE switch setting. Band 1 consists of two amplifiers. Bands 2 and 3 each consist of one doubler and one amplifier.

a. Band 1 (fig. 15). The band 1 circuit consists of V301 and V302. When the FUNCTION SWITCH is in the FINE position, the 240-volt plate supply is connected to both tubes through the filter composed of L301 and C314. When the RANGE switch is at 10–21.7 MC, the plate voltage is furnished to V301 through the primary of T301. Screen-grid voltage for V301 is supplied through dropping resistor R303 and the screen is bypassed by C301B. Plate voltage for V302 is applied through R307, R326, and peaking coil L312. The screen voltage is taken from the junction of R307 and R326 and this point is bypassed to ground by C313. The variable 416.6- to 434-kc standard basic frequency from the balanced modulator is coupled to J302 and applied to the grid of amplifier V301 through C340. Resistor R301 is the grid-return resistor. Bias for this stage is developed across cathode resistor R302 which is bypassed by C301A. The output of V301 is coupled to the network Z301, which consists of two double-tuned transformers T301 and T302. The primary of T301 and capacitors C305, C304, and C303A form the plate load.

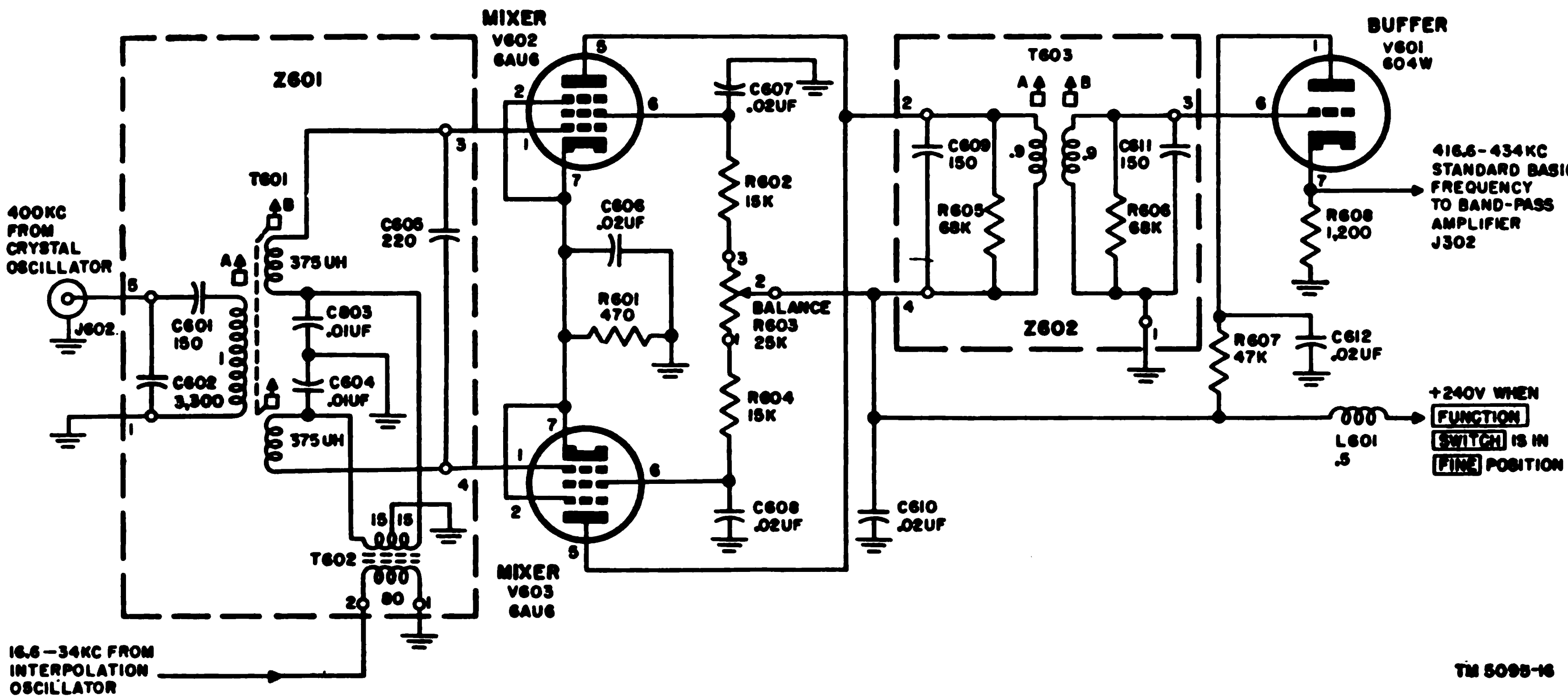


Figure 14. Balanced modulator, simplified schematic diagram.

Capacitor C303 is the main tuning capacitor; its four sections are gang-tuned. Capacitor C304 is a trimmer for the first tuned circuit, and C305 is the fixed tuning capacitor. The output is coupled to the secondary of T301 which is tuned by main tuning capacitor C303B, trimmer C306, and fixed capacitor C307. The output of the transformer secondary is coupled to the primary of T302 which is tuned by main tuning capacitor C303C, trimmer C308, and fixed capacitor C302; and from this primary to its secondary which is tuned by C303D, trimmer C310, and fixed capacitor C311. Trimmer C312 couples a small portion of the output from the plate of V301 to the fourth tuned circuit. A voltage divider in the plate circuit of V301, consisting of R304 and R305, is used to provide a test voltage at TP301. The output of the quadruple-tuned network is coupled through C341 to the grid of amplifier V302. The quadruple-tuned filter discriminates strongly against the undesired frequencies, such as the crystal oscillator, interpolation oscillator, and their difference frequency, and other spurious modulation products which may appear at the input to this stage. This discrimination is essential to prevent spurious beats in the rf tuner against both the unknown and the desired standard basic frequency harmonic. The output, which is coupled through C341 and R325 to V302, is thus sharply tuned in favor of the selected standard basic frequency and is of approximately uniform amplitude over the 17.4-kc tuning range. Power amplification is provided by V302. Cathode bias is developed by the parallel combination R308, R327, and C342. The band switch connection increases the bias by removing R327 from the circuit when band 2 or 3 is in use. The output is coupled by C315 to section 2 of S301. When the switch is in the 10–21.7 MC position, the output is connected to the band 1 circuit in the rf tuner through J303. For any other position of the RANGE switch, the output is connected to the grid of V303 through the switch.

b. Band 2 (fig. 16). When the RANGE switch is turned from the 10–21.7 MC to the 21.7–46.7 MC position, the 240-volt plate supply voltage is applied to the band 2 circuit through section 3 of the switch. The band 2 circuit is composed of doubler stage V303 and amplifier stage V304. The output of the band 1 circuit is applied through section 2 of switch S301 to the grid of V303. Grid return is provided by R309, and a test point is provided by TP302. Stage V303 is cathode biased by R310 and C316A. Plate and screen voltages are supplied through decoupling network R313 and C316B. The quadruple-tuned network, Z302, produces a symmetrical over-all response characteristic curve with steep skirts and a relatively flat top centered at 850 kilocycles, which is the center of the band of second harmonics of the standard basic frequency. The result is that the second harmonic of the standard basic frequency is passed, and both the fundamental and third harmonics are attenuated by over 100 decibels (db) with increased attenuation for higher order harmonics. The output of Z302 is coupled to the triode-connected pentode buffer-amplifier V304 through capacitor C346 and resistor R324. The plate, screen grid, and suppressor grid are tied together to plate load resistor R314. The output is coupled from the plate through C323 to section 1 of RANGE switch S301. When this switch is at 21.7–46.7 MC, the output is connected to the band 2 circuit of the rf tuner through J304. When it is at 46.7–100 MC, the output is connected to the grid of V305 through the switch. Test points are provided in the plate circuit of doubler V303. The output of V304 is coupled through C317 to test point TP303 and voltage divider R311 and R312. Test point TP304 is at the junction of the voltage divider.

c. Band 3 (fig. 17). When the RANGE switch is turned from the 21.7–46.7 MC position to the 46.7–100 MC position, the 240-volt plate supply voltage is applied to the band 3 circuit, which consists of doubler V305 and amplifier V306. The output of the band 2 circuit is now disconnected from the band 2 circuit of the rf tuner, and connected to the grid (pin 1) of V305. The input voltage is developed across R316. Cathode bias is developed by R317 and C324A. Screen and plate voltages are applied through resistor R320, which, with C324B forms a decoupling network. The quadruple-tuned network Z303 produces a symmetrical output curve with steep skirts and a relatively flat top centered at 1,700 kilocycles, which is the center of the band of fourth harmonics of the standard basic frequency. The result is that the fourth harmonic of the standard basic frequency (second harmonic of the input signal to this stage) is passed, and the other signals present in this stage are attenuated 100 db or more. The output of the network is coupled through C343, and the voltage developed across grid resistor R323 is applied to the grid of output amplifier V306. This stage provides both power gain and harmonic accentuation. Cathode bias is provided by R322 and C344. The plate load resistor is R328. A decoupling circuit is formed by R321 and C330. Screen

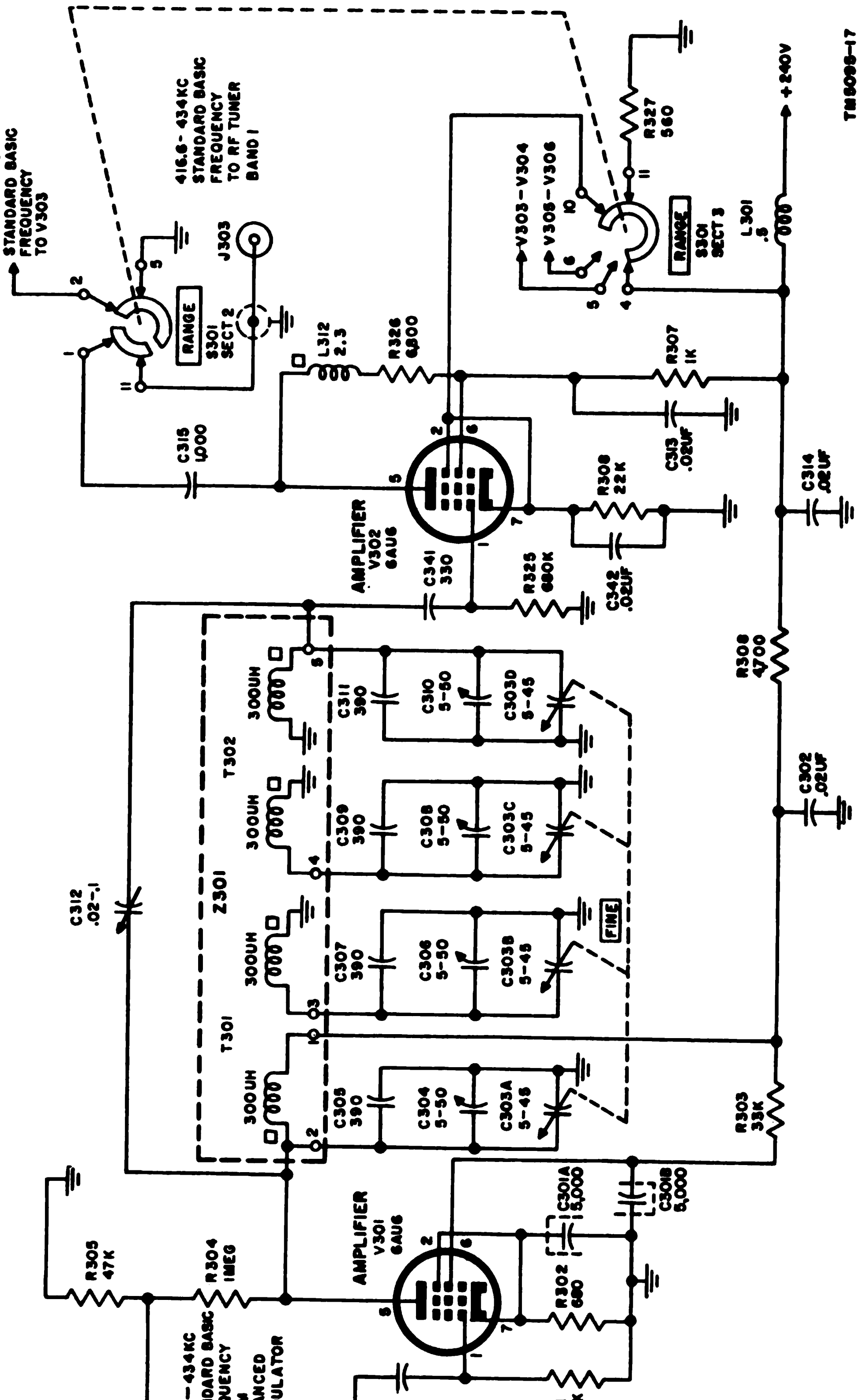


Figure 15. Band-pass amplifier, band 1 circuit, simplified schematic diagram.

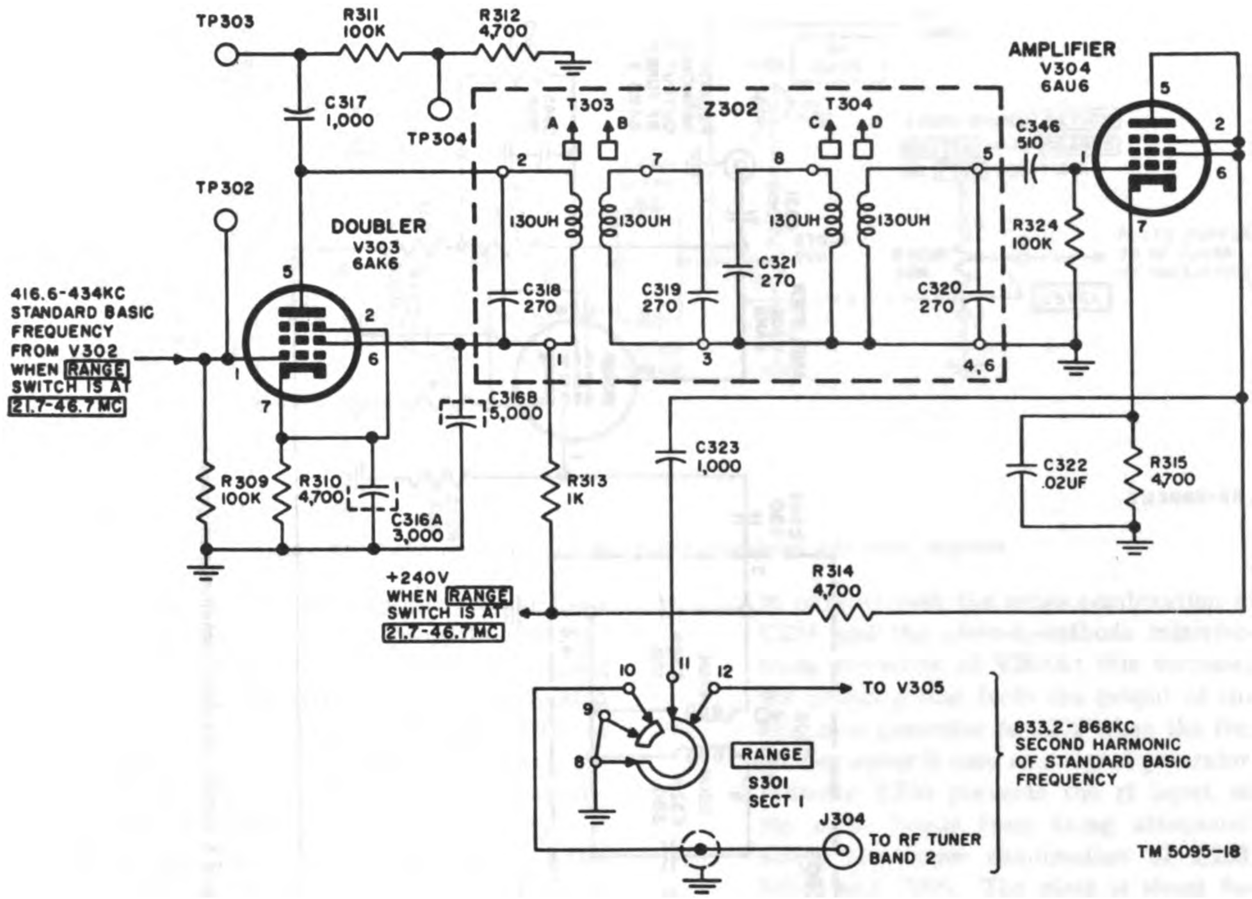


Figure 16. Band-pass amplifier, band 2, simplified schematic diagram.

voltage is supplied through dropping resistor R329 and the screen is kept at rf ground potential by C345. The output is coupled by C331 through J305 to the band 3 circuit of the rf tuner. Test points TP306 and TP307 are provided in the plate circuit, and TP305 is located in the grid circuit of V305.

44. Audio Oscillator
(fig. 18)

a. Audio oscillator V105, a 6BN6 tube, is an electron-coupled, relaxation oscillator whose purpose is to supply an 800 ± 300 cps signal to the modulator when the FUNCTION SWITCH is in the COARSE position.

b. In this circuit, the plate and quadrature grid (pin 6) are tied together. Plate voltage is supplied through R104. The accelerator grid (pin 5) is operated at voltages considerably higher than average. The accelerator and control grid (pin 2) are coupled together through C105. A rise in accelerator grid voltage is coupled to the control grid and abruptly increases the total space current. The resultant increase in accelerator grid current produces a higher voltage drop across load resistor R106, which is fed back to the control grid. The grid voltage, however, is still above the step value, so that the total space current remains the same. When the grid voltage decays to the step value, the total space current is decreased abruptly, the accelerator voltage rises, and the process repeats itself. The circuit values are such that this cycle repeats itself 800 times a second, producing an 800-cycle saw-tooth voltage across plate capacitor C104. The signal voltage is coupled by C103 and R702 to the audio modulator.

c. The audio modulator is of the absorption type and modulates the rf input during COARSE operation by means of the 800-cycle signal from the audio oscillator. The 800-cycle signal is applied through the low-pass filter (composed of C701, L701, and C702) to the plates of parallel crystal diodes CR701 and CR702. The filter removes the high-frequency components of the saw tooth; this results in a smoother 800-cycle signal and ap-

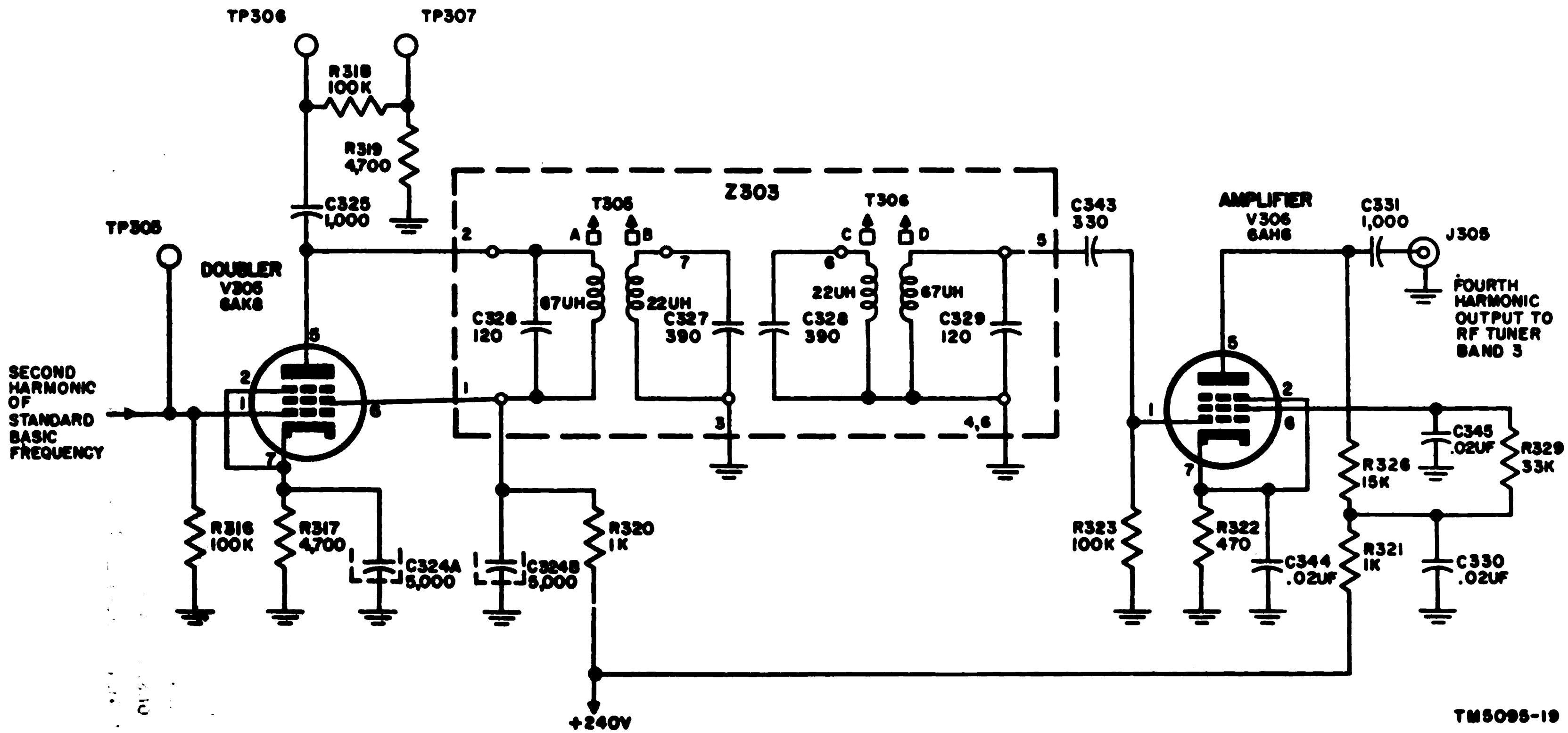


Figure 17. Band-pass amplifier, band 3 circuit, simplified schematic diagram.

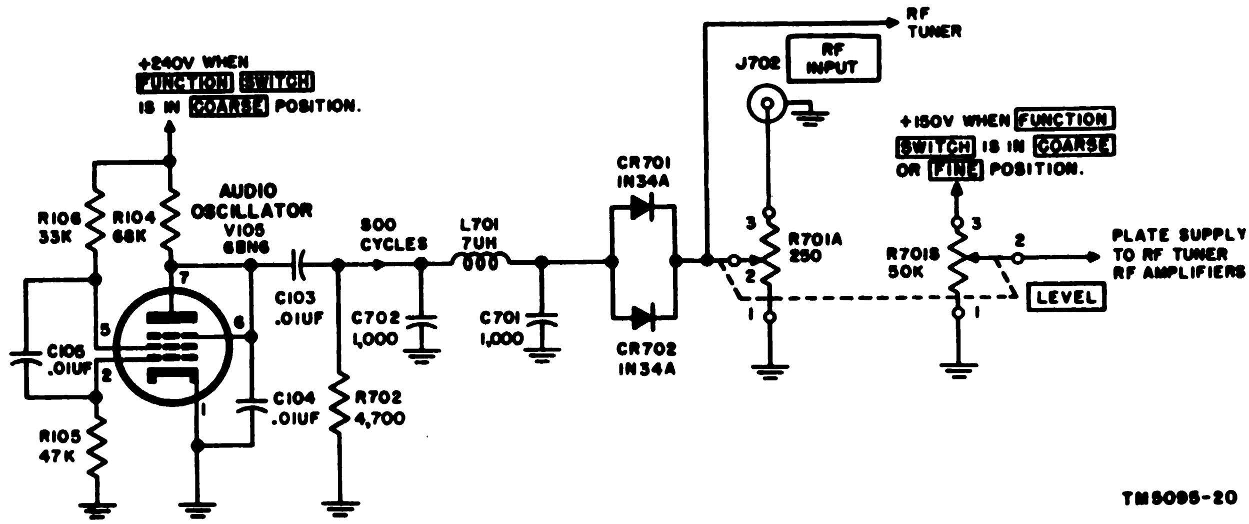


Figure 18. Audio oscillator and modulator, simplified schematic diagram.

proaches a sine wave in form. On the positive half-cycles, the diodes conduct in proportion to the applied voltage; therefore, they present a varying resistance in series with R701A. If an unmodulated rf signal is applied through input jack J702 to R701A, an 800-cycle amplitude-modulation envelope will be superimposed upon it. The amplitude of the rf signal may be adjusted by the LEVEL control, which at the same time adjusts the plate voltage of the rf tuner amplifiers at R701B.

45. Rf Tuner

The rf tuner is divided into three separate amplifier-detector pairs; each one is used on one of three bands. The band 1 circuit is composed of V201 and CR201; the band 2 circuit has V202A, V203A, and CR202; and the band 3 circuit has V202B, V203B, and CR203. Each band circuit consists of a tuned rf amplifier, a harmonic generator, and a mixer or detector for COARSE tuning to the frequency under measurement.

a. Band 1 Circuit (fig. 19).

(1) An rf input signal is applied to the band 1 circuit when the FUNCTION SWITCH is in the COARSE or FINE position, and the RANGE switch is in the 10–21.7 MC position. The signal under measurement is applied through choke L205 and coupling capacitor C206 and is developed across inductance L203 and cathode resistor R201. The stage is a grounded-grid minimum noise circuit. Capacitor C205 is in parallel with the series combination of C204 and the plate-to-cathode interelectrode capacitor of V201A; this increases the coupling that feeds the output of the harmonic generator to J202 when the frequency meter is used as a signal generator. Inductor L205 prevents the rf input on the other bands from being attenuated across the series combination of L203, R201, and C205. The plate is shunt fed through the filter composed of L201, L202, C201, C202, and C203. Plate voltage is determined by the setting of the LEVEL control through R701A. When the FUNCTION SWITCH is operated in the COARSE position, the rf input is modulated, and there is no standard basic frequency input at J202. The plate tank circuit, which consists of C207A, C207B, and L204, is tuned to the rf input frequency by the COARSE control, which is geared to C207A. When the circuit is tuned, the modulation envelope which has been superimposed on the rf input will be detected by V201B, a low-level, grid-leak detector. Detection is accomplished in the grid circuit by R203 and C208. Plate voltage is reduced to 30 volts by the drop across resistors R204 and R205. The 800-cycle audio output is taken from the top of the low-pass filter (R205, C212, and C213) and coupled through C209 to the audio amplifier. Plate supply rf filtering is provided by R217, C210, and C211.

(2) When the FUNCTION SWITCH is turned to the FINE position, the modulation is removed from the rf input, and the standard basic signal frequency is applied through P303 across R202 and to harmonic generator CR201. This crystal is operated at the knee of its dc current-voltage characteristic curve. The resultant harmonics are coupled to the tank circuit of V201B through a tap on L204. Since this circuit has just been coarse tuned to the rf input under measurement, it is also tuned to the harmonic of the standard basic frequency nearest to the input. The hairline on the band 1 dial (yellow) indicates that harmonic number. Since there is overlapping of the upper ranges of one band with the lower ranges of another, some of the upper harmonics are omitted from each section of the COARSE tuning dial. This simplifies the reading of the COARSE tuning dial and the calibration book. The 49th harmonic is omitted from the band 1 dial. The input to the grid of V201B is sharply tuned to the frequency of the signal under measurement; this also selects the proper harmonic generated by CR201. Mixing of the two signals takes place at the grid of V201B. The frequency difference between these two signals is demodulated by V201B; all higher rf and audio frequencies are eliminated by the filter network in the plate circuit. As the interpolation oscillator is tuned by the FINE control, the standard basic frequency as applied to the crystal varies. When the interpolation oscillator frequency preselected harmonic equals the rf frequency, a zero-beat condition is obtained, as evidenced by the lack of audio output, or more precisely, the zero-beat indication on the TUNING METER. Band 1 covers from the 24th to the 50th harmonic of the standard basic frequency.

b. Band 2 (fig. 39). Plate power is removed from the band 1 circuit and supplied to the band 2 circuit when the RANGE switch is advanced to the 21.7–46.7 MC position (FUNCTION SWITCH in the COARSE or FINE position). The circuit is similar to the band 1 circuit and is tuned by the C section of C207. The band 2 circuit output of the band-pass amplifier is the second harmonic of the standard basic frequency; this output is applied to harmonic generator CR202. The tank circuit of V202A covers the range of the 54th to 108th harmonics of the standard basic frequency. The 98th and 102nd harmonics of the second harmonic of the basic frequency are omitted from the COARSE tuning dial. The demodulated audio in the COARSE position and the difference-frequency audio in the FINE position are coupled through C219 to the audio amplifier.

c. Band 3 (fig. 39). Plate power is removed from the band 2 circuit and applied to the band 3 circuit when the RANGE switch is advanced to the 46.7–100 MC position (FUNCTION SWITCH in the COARSE or FINE position). The circuit is similar to the band 2 circuit and is tuned by the E and G sections of split-stator capacitor C207. The band 3 circuit output of the band-pass amplifier is the fourth harmonic of the standard basic frequency, and this is applied to harmonic generator CR203. The tank circuit of V202B covers the range of the 112th to 232d harmonics of the standard basic frequency. The 196th, 204th, 212th, 220th, and 228th harmonics are omitted from the dial. The demodulated audio in COARSE and the difference-frequency audio in FINE are coupled through C229 to the audio amplifier.

46. Audio Amplifier

The audio amplifier is fed audio signals from the rf tuner when the FUNCTION SWITCH is set to COARSE or FINE or the audio output of the check circuit is set to CHECK, and provides both an audible and a visual output. It consists of first audio amplifier V106, second audio amplifier V107, meter and gate output V108A, and audio output V108B.

a. First Audio Amplifier (fig. 20). Grid resistor R108 is connected by the D section of FUNCTION SWITCH S701 to the output of the rf tuner when set at COARSE or FINE, and to the output of the check circuit when set at CHECK. Fixed bias is provided by a voltage divider (across the 150-volt supply) consisting of R111, R110, R107, and either R704, R705, or R706, depending on the switch setting. The C section of S701 selects one of these resistors as gain compensation for the difference in input level, thus providing the same output level in each function. Cathode resistor R107 is bypassed by C106A and the plate circuit is decoupled by R110 and C106B. The plate and screen are tied

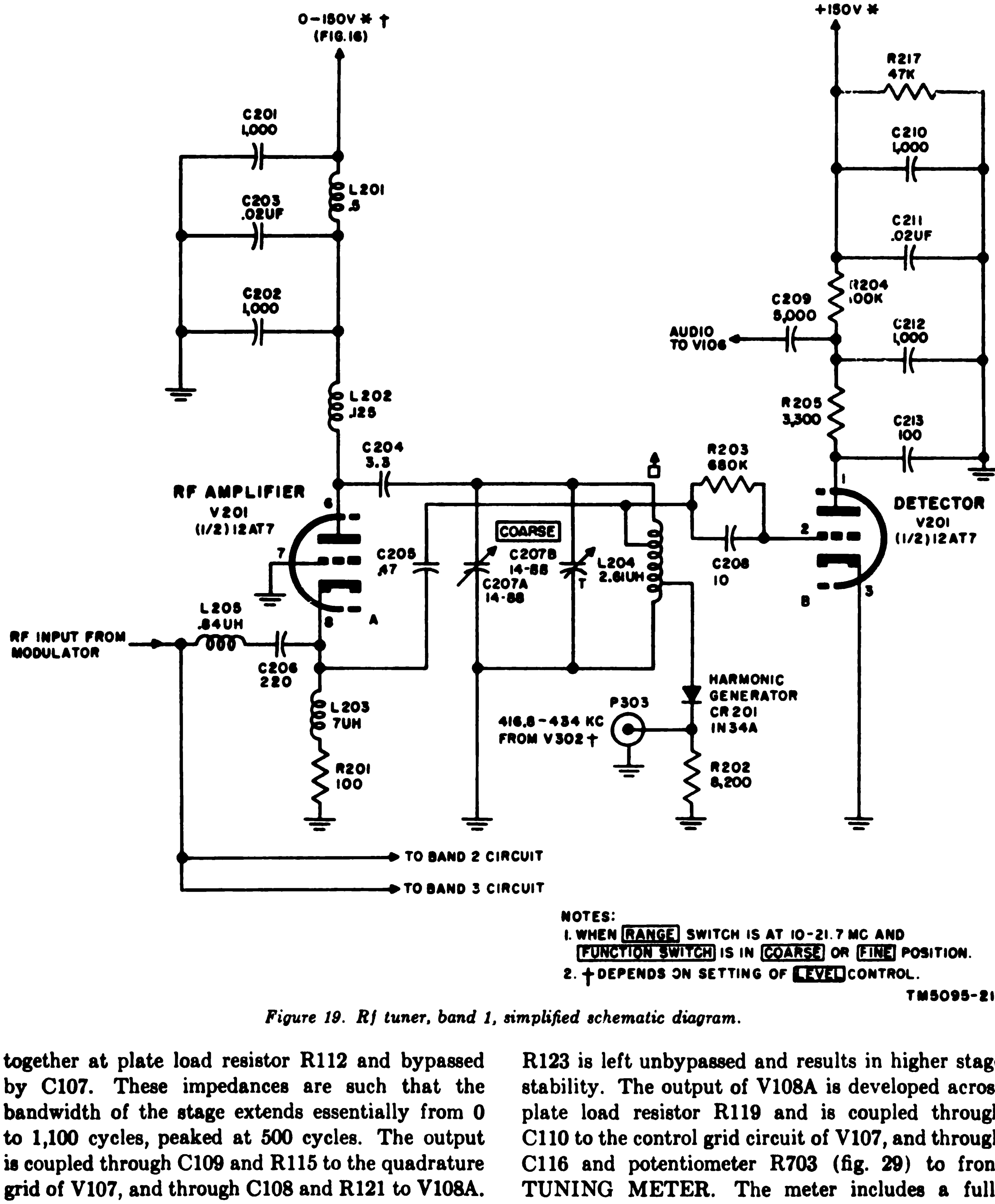


Figure 19. Rf tuner, band 1, simplified schematic diagram.

together at plate load resistor R112 and bypassed by C107. These impedances are such that the bandwidth of the stage extends essentially from 0 to 1,100 cycles, peaked at 500 cycles. The output is coupled through C109 and R115 to the quadrature grid of V107, and through C108 and R121 to V108A.

b. Meter and Gate Output Control (fig. 20). Meter and gate output tube V108 is a voltage amplifier that supplies an output voltage to the TUNING METER and provides gating control to the second audio amplifier. Cathode-bias resistor R123 is left unbypassed and results in higher stage stability. The output of V108A is developed across plate load resistor R119 and is coupled through C110 to the control grid circuit of V107, and through C116 and potentiometer R703 (fig. 29) to front TUNING METER. The meter includes a full-wave crystal rectifier and is adjusted for proper scale deflection by R703.

c. Second Audio Amplifier (fig. 20). Second audio amplifier V107 uses a 6BN6 tube that provides gating of the audio output to the headphones. The accelerator grid (pin 5) is supplied 95 volts through R117, which is bypassed by C113. The limiter grid (pin 2) is at ground potential in the absence of the signal. Cathode bias is provided by R109 and R116 and is adjusted by R116 to —3.5 volts, the cutoff value. The audio output of first audio amplifier V106 is coupled through grid resistor R115 and C109 to the quadrature grid (pin 6). No output appears at the plate, however, until the limiter grid is brought above cutoff by the signal coupled to it from V108. This signal is rectified by half-wave rectifier CR101. The resultant positive half-waves are filtered by resistor R114 and capacitor C111 and applied to the limiter grid, so that the limiter grid is maintained at a few volts positive. Negative feedback, needed to stabilize the stage, is provided by leaving the cathode resistor unbypassed. The action of R113, together with the large time constant of the grid circuit, requires that the output of V108A is of sufficient amplitude and low enough frequency to keep the gate open. The gating action of the second stage results in the selection of true responses and rejection of spurious signals and noises. Capacitor C112 reduces the possibility of oscillation. The output across plate load resistor R118 is coupled through C114 and R120 to the audio output stage.

d. Audio Output (fig. 20). The response of this stage is made essentially uniform over the selected frequency range by providing negative feedback voltage from output transformer T102 through C115 to the top of cathode resistor R122. Plate voltage is applied through the primary of output transformer T102, and the output is developed across the primary. The output voltage induced in the secondary is connected to headphones through PHONE jack J703.

47. Power Supply

POWER switch S702, when turned on, applies input power to the primaries of power transformer T101. The 110V–220V switch S101 connects the two primaries in parallel for 110-volt operation and in series for 220-volt operation. Fuses F701 and F702 provide circuit protection.

a. Filament Supplies (fig. 39). The 6.4-volt filament supply for the power supply chassis, which includes the audio oscillator and audio amplifier, is taken from secondary terminals 11 and 13. The 6.5-volt filament supply for the rest of the frequency meter is taken from secondary terminals 8 and 10.

b. +240-volt Supply (fig. 21). Secondary terminals 5 and 7 supply plate power to two full-wave rectifiers, V101 and V102, connected in parallel for greater current output. The pulsating output is filtered by L101, C101, L102, and C102 and produces +240 volts across bleeder R103.

c. +150-volt Supply (fig. 21). Voltage regulator V103 is connected to the +240-volt supply through series resistor R101. The tube maintains a constant 150-volt drop between its plate and cathode.

d. +108-volt Supply (fig. 21). The plate of voltage regulator V104 is connected to the +240-volt supply through series resistor R102. The tube maintains a constant 108-volt drop between its plate and cathode.

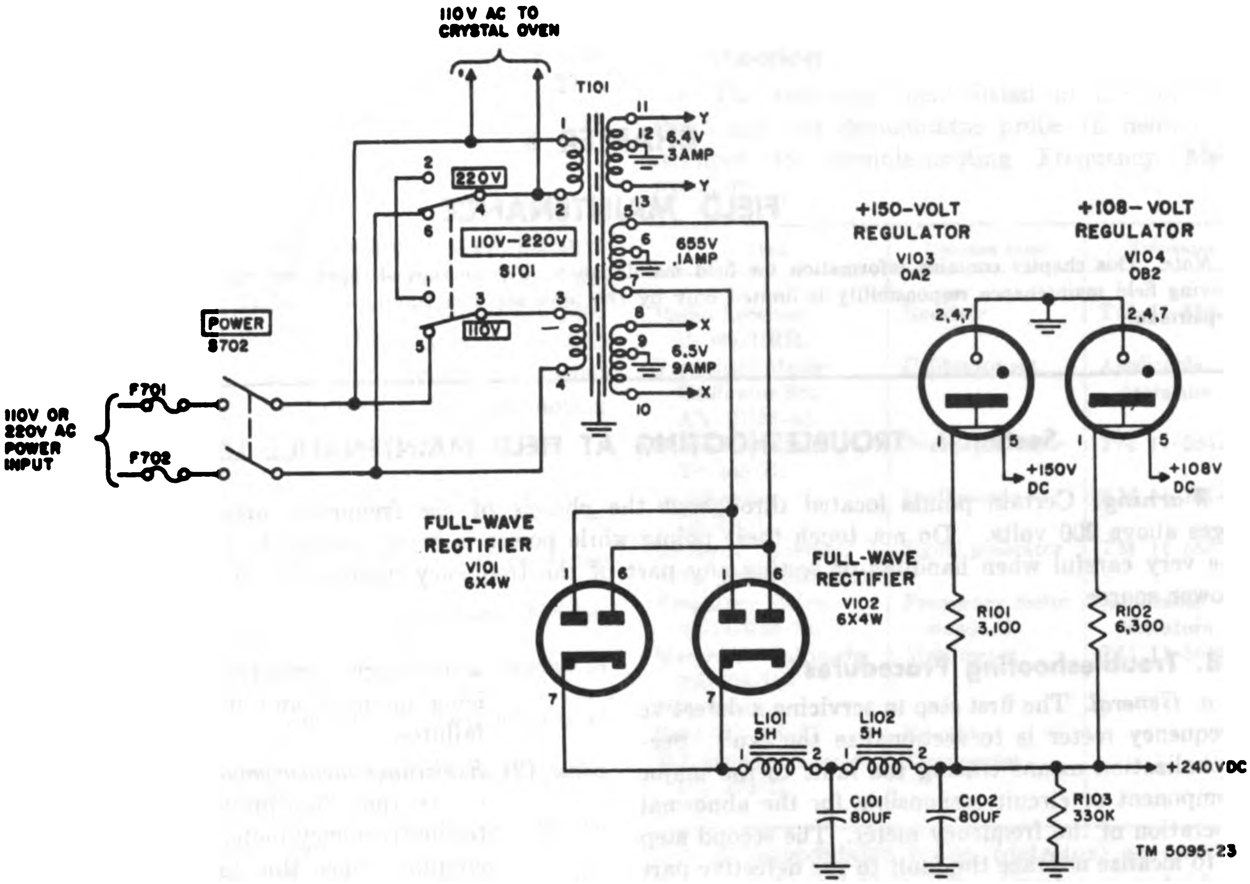


Figure 21. Power supply, simplified schematic diagram.

CHAPTER 6

FIELD MAINTENANCE

Note. This chapter contains information for field maintenance. The amount of repair that can be performed by units having field maintenance responsibility is limited only by the tools and test equipment available and by the skill of the repairman.

Section I. TROUBLESHOOTING AT FIELD MAINTENANCE LEVEL

Warning: Certain points located throughout the chassis of the frequency meter operate at voltages above 200 volts. Do not touch these points while power is being applied to the frequency meter. Be very careful when handling or testing any part of the frequency meter while it is connected to the power source.

48. Troubleshooting Procedures

a. General. The first step in servicing a defective frequency meter is to sectionalize the fault. Sectionalization means tracing the fault to the major component or circuit responsible for the abnormal operation of the frequency meter. The second step is to localize or trace the fault to the defective part responsible for the abnormal condition. Some faults, such as burned-out resistors and shorted transformers, often can be located by sight, smell, and hearing. The majority of faults, however, must be localized by checking voltages and resistances.

b. Component Sectionalization and Localization. Listed below is a group of tests arranged to simplify and reduce unnecessary work and aid in tracing a trouble to a specific component. The simple tests are used first. Those that follow are more complex. Follow the procedure in the sequence given. A serviceman must be careful to cause no further damage to the frequency meter while it is being serviced. In general, the trouble is traced to a section of the frequency meter, the faulty component in that section is located, and the trouble is remedied. The service procedure is summarized as follows:

(1) *Visual inspection.* The purpose of visual inspection is to locate any visible trouble. Through inspection alone, the repairman frequently may discover the trouble or determine the circuit in which the trouble exists. This inspection is valuable in avoiding damage to the frequency meter, which might occur through improper servicing methods and in forestalling future failures.

(2) *Resistance measurements.* These measurements (par. 52) prevent further damage to the frequency meter from possible short circuits. Since this test gives an indication of the condition of the filter circuits, its function is more than preventive.

(3) *Operational test.* The operational test is important because it frequently indicates the general location of trouble. In many instances, the information gained will determine the exact nature of the fault. To utilize this information fully, all symptoms must be interpreted in relation to one another.

(4) *Troubleshooting chart.* The trouble symptoms listed in this chart (par. 53) will aid greatly in localizing trouble.

(5) *Signal substitution.* Signal substitution generally is not used for troubleshooting in an item of test equipment. However, if the proper signal generators are available, it is possible to use signal substitution to an advantage in some cases.

(6) *Intermittents.* In all these tests, the possibility of intermittent conditions should not be overlooked. If present, this type of trouble often may be made to reappear by tapping or jarring the equipment. It is possible that some external connection may

cause trouble. Test wiring for loose connections; move wires and components with an insulated tool, such as a fiber rod. This may show where a faulty connection or component is located.

49. Troubleshooting Data

Caution: Always check the circuit label, because the schematic diagram in the manual may not include circuit changes made during equipment production. Take advantage of the material supplied in this manual. It will help in the rapid location of faults. Consult the following troubleshooting data:

Fig. No.	Title
28	Frequency Meter FR-5/U, location of parts, top view.
33	Frequency Meter FR-5/U, band-pass amplifier, location of parts, bottom view.
27	Frequency Meter FR-5/U, rf tuner, location of parts, top view.
38	Frequency Meter FR-5/U, rf tuner, location of parts, bottom view.
22	Frequency Meter FR-5/U, power supply, location of parts, top view.
31	Frequency Meter FR-5/U, power supply, location of parts, bottom view.
35	Frequency Meter FR-5/U, interpolation oscillator, location of parts, bottom view.
36	Frequency Meter FR-5/U, balanced modulator, location of parts, bottom view.
37	Frequency Meter FR-5/U, crystal oscillator, location of parts, bottom view.
23	Tube socket voltage and resistance diagram, with FUNCTION SWITCH in COARSE position.
24	Tube socket voltage and resistance diagram, with FUNCTION SWITCH in FINE position.
25	Tube socket voltage and resistance diagram, with FUNCTION SWITCH in CHECK position.
34	Frequency Meter FR-5/U, wave forms.
39	Frequency Meter FR-5/U, complete schematic diagram.
40	Frequency Meter FR-5/U, main frame wiring and interconnection diagram.
41	Frequency Meter FR-5/U, power supply, wiring diagram.
42	Frequency Meter FR-5/U, rf tuner, wiring diagram.
43	Frequency Meter FR-5/U, band-pass amplifier, wiring diagram.
44	Frequency Meter FR-5/U, interpolation oscillator, wiring diagram.
45	Frequency Meter FR-5/U, crystal oscillator, wiring diagram.
46	Frequency Meter FR-5/U, balanced modulator, wiring diagram.
47	Resistor color codes.
48	Capacitor color codes.

50. Test Equipment Required for Troubleshooting

a. The test equipment listed in the following chart and the demodulator probe (*b* below) are required for troubleshooting Frequency Meter FR-5/U:

Item	Common name	References
Radio Receiver R-389/URR.	Receiver	TM 11-855
Frequency Meter Calibrator Set AN/URM-18.	Calibrator set	Applicable literature
Signal Generator TS-465/U.	Sweep generator	TM 11-2642
Oscilloscope OS-8A/U.	Oscilloscope	TM 11-1214
Rf Signal Generator Set AN/URM-25B.	Signal generator	TM 11-5551B
Frequency Meter AN/URM-79.	Frequency meter standard.	Applicable literature
Electronic Multimeter TS-505/U.	Multimeter	TM 11-5511
Pad, 30-db		
Cord CG-409/U.	Rf cable	
T-Junction Connector UG-274/U.	T-connector	

b. A demodulator probe (detector) is required for a number of tests. The detector may be built easily by following the diagram in figure 32. Materials used in the construction of the demodulator probe are listed below.

Component	Description
R1	10K ohms, ½ w
R2	68K ohms, ½ w
R3	33K ohms, ½ w
CR1	Germanium crystal
C1	3,000 uuf, mica

51. General Precautions

Observe the precautions given below very carefully whenever servicing the frequency meter:

Note. To remove a subchassis, loosen the retaining screws and disconnect the electrical plugs. These screws are painted black. To remove the subchassis cover, remove the screws that have *black rings* stenciled *around* them.

a. Be careful when the frequency meter is removed from the dust cover; dangerous voltages are exposed.

b. If the frequency meter has been operating for some time, use a cloth to remove the metal tube shields and a tube puller to remove the tubes; this prevents burning the hand or fingers.

c. When servicing the front end, do not disburb the placement of parts, and be careful not to bend the tuning capacitor plates. This could cause a short circuit or a change of alinement.

d. Do not overtighten screws when assembling mechanical couplings.

e. When changing a component that is held by screws, always replace the lockwashers.

f. Careless replacement of parts often leads to new faults. Note the following points:

(1) Before a part is unsoldered, note the position of the leads. If the part has a number of connections, such as a power transformer, tag each lead.

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

(3) Use a small, rather than a large, soldering iron when soldering small resistors or ceramic capacitors. Overheating of the small parts may ruin or change the value of the component.

(4) Do not allow drops of solder to fall into parts of the chassis because they may cause short circuits.

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

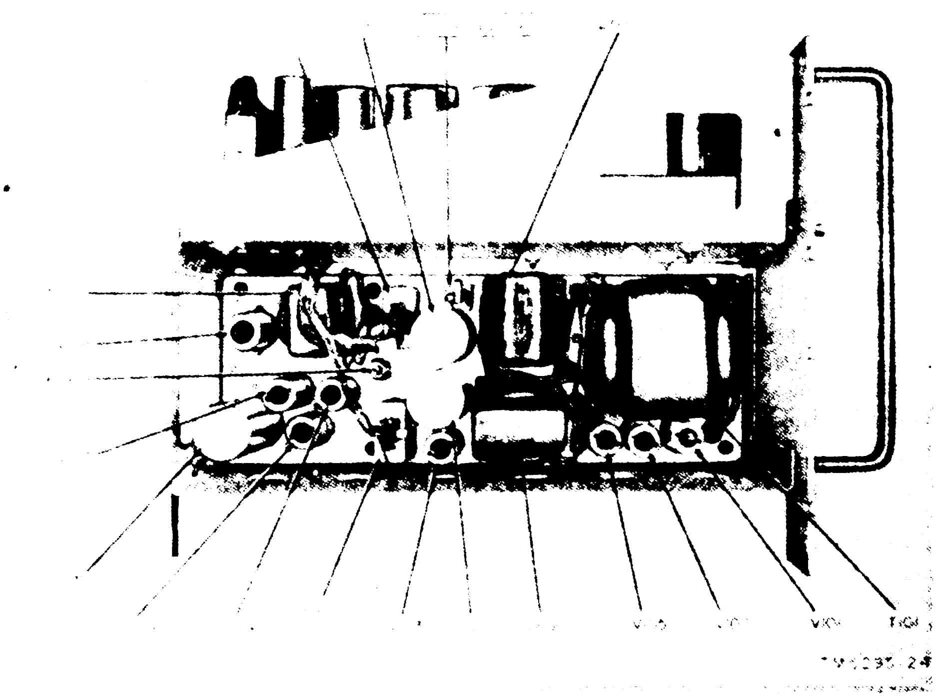


Figure 22. Frequency Meter FR-5/U, power supply, location of parts, top view.

(6) When a part is replaced in a high-frequency circuit, place it exactly in the position occupied by 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 as in the original wiring. Failure to observe these precautions may result in decreased output or parasitic oscillations.

(7) *Do not disturb* any of the alinement adjustments unless it definitely has been determined that the trouble is caused by misalinement.

52. Checking B+ Circuits for Shorts
(figs. 21 and 22)

a. At the output of the filter section of the power supply, the B+ voltages are distributed to the various subchassis located within the equipment. If the B+ voltages indicate a low reading, it is likely that the trouble lies in the power supply circuit. This may be caused by a faulty rectifier tube or voltage regulator tube, an open filter choke, or a shorted filter capacitor. When the defect that causes an abnormal B+ voltage condition is in some other circuit, it probably will show up only by removing the defective subchassis, allowing B+ to be restored to its full value. The methods to be used for checking and correcting the circuits are outlined in *b* and *c* below. Refer to the overall schematic diagram (fig. 39) and the voltage and resistance measurements (figs. 23, 24, and 25).

b. A trouble in any circuit will be noticed when following the operating procedures in paragraphs 15 through 20. These troubles will be indicated in the equipment performance check list (par. 38). Normally, using this procedure will narrow down the location to a section of the frequency meter or, perhaps, even to one particular stage. Sometimes, if the B+ circuit is shorted at the decoupling network of one stage, it may drop the voltage so that several stages are affected.

c. The following chart gives the points at which the 240-volt, 150-volt, and 180-volt B+ circuits may be checked. Refer to the voltage measurements in figures 23, 24, and 25 for the actual values to be found at these points.

Note. FUNCTION SWITCH must be in the FINE position.

B + check points	
Chassis	Tube or jack pin No.
240-volt circuit	
Power supply	J101–4 V-108–6
Ban-pass amplifier:	J301–4
All bands	V301–5
All bands	V302–5
Bands 2 and 3	V303–5
Bands 2 and 3	V304–5
Band 3 only	V305–5
Band 3 only	V306–5
Balanced modulator	J601–6 V601–5 V602–5 V603–5
150-volt circuit	
Power supply	J102–4 V106–5
Rf tuner:	J201–15 J201–7
Band 1 only	V201–6
Band 2 only	V202–1
Band 3 only	V203–6
108-volt circuit	
Crystal oscillator	J501–4 V501–6 V502–6 V503–6 V504–6

53. Troubleshooting Chart

The following chart is supplied as an aid in locating trouble in the frequency meter. It lists the symptoms which the repairman observes, either visually or audibly, while making a few simple tests. The chart also indicates how to localize trouble quickly to a subchassis. After the trouble has been localized to a stage or circuit, a tube check and voltage and resistance measurments of this stage or circuit ordinarily should be sufficient to isolate the defective parts. Normal voltage and resistance readings are given on figures 23, 24, and 25.

Symptom	Probable trouble	Correction
1. No film light when POWER switch is turned on.	Defective lamp I 704, and/or I 705.	Replace defective lamp.
2. No coarse tuning dial light when POWER switch is turned on.	Defective lamp I 701, I 702, or I 703.	Replace defective lamp.
3. Frequency meter inoperative.	Open fuses F701 and/or F702.	See item 4.
	Failure of filament and/or one or more B+ supplies.	Refer to items 4, 5, 6 and 7.
	Plug P701 not connected to power source.	Connect plug P701 to power source.
4. Blown fuses F701 and F702.	Shorted filter capacitors.	Replace defective capacitors.
	Shorted or overloaded filament circuits.	Check T101 secondary windings. If abnormal, check winding, then individual filament circuits. Replace defective components.
	Shorted or overloaded B+ circuits.	Check T101 hv secondary winding. If abnormal, check B+ circuits. Check filter capacitors C101 and C102. Replace defective component.
5. Low 240-volt circuit voltages.	Defective tubes V101 and V102.	Replace defective tubes.
	Defective filter capacitors C101 and C102.	Replace defective capacitor.
6. Low 150-volt circuit voltages.	Defective tube V103.	Replace V103.
	Low 240-volt supply.	See item 5.
7. Low 108-volt circuit voltages.	Defective tube V104.	Replace V 104.
	Low 240-volt supply.	See item 5.
8. Weak or no audio tone in COARSE operation although normal in FINE or CHECK.	Defective tube V105. Defective crystals CR701, CR702.	Replace V105. Replace defective crystal.
9. Weak or no audio tone in FINE operation, although normal in COARSE.	Defective interpolation oscillator.	Replace defective tubes. Make voltage and resistance measurements. If fault is found, replace entire subchassis.
	Defective crystal oscillator and/or frequency dividers.	Refer to item 13.
	Defective balanced modulator.	Refer to item 15.
	Defective band pass amplifier.	Refer to items 16 and 17.
10. Weak or no audio tone in CHECK operation although normal in FINE.	Defective check circuit.	Refer to item 18.
11. Audio tone normal in CHECK operation but not in COARSE or FINE.	Defective balanced modulator.	Refer to item 15.
	Defective band-pass amplifier.	Refer to items 16 and 17.

Symptom	Probable trouble	Correction
12. No audio tone obtainable at PHONE jack.	Audio amplifier defective.	Refer to item 19.
	B+ circuits defective.	Refer to items 5, 6, and 7.
13. Crystal oscillator not producing a stable 3.6-mc signal.	Aging of crystal.	Compensate as instructed in paragraph 68*a*. If V501 and V502 are normal, but proper output cannot be obtained or output is erratic, replace crystal oven unit.
	Defective tubes V501 and V502.	Replace defective tube or tubes.
14. Frequency dividers do not produce a stable 400-kc signal.	Crystal oscillator circuits out of alinement.	Aline as instructed in paragraphs 68*a* and 68*c*.
	Defective circuit component.	Check voltage and resistance values and replace defective components.
	Defective networks Z502 and Z503.	Check networks as instructed in paragraph 74.
	Defective tubes V503 and V504.	Replace defective tubes.
15. Balanced modulator output is low and/or contains modulation products other than the sum frequency.	Input circuit and/or output circuit out of alinement.	Aline as instructed in paragraph 67.
16. Band-pass amplifier output is low on one or more bands.	Input voltage is low.	Refer to item 15.
	Band-pass amplifier out of alinement on one or more bands.	Aline as instructed in paragraph 66*b*.
	Defective tubes V301, V302, V303, V304, V305, and V306.	Replace defective tubes.
17. Band-pass amplifier output is modulated.	On band 1 only: presence of crystal oscillator frequency and/or interpolation oscillator harmonics at V302 input.	Aline band 1 as instructed in paragraph 66*b*(1).
	On band 2 only: presence of standard basic frequency at input to V304.	Aline band 2 as instructed in paragraph 66*b*(4).
	On band 3 only: presence of second harmonic of standard basic frequency at input to V306.	Aline band 3 as instructed in paragraph 66*b*(5).
	On more than one band: more than one band circuit mistuned.	Aline all faulty bands in numerical order.
18. Check circuit output is low.	Defective tube V506.	Replace V506.
	Network Z503 is mistuned.	Aline as instructed in paragraph 68.
	Crystal CR501 is defective.	Replace Z504.
19. Audio amplifier output is low.	Defective tubes V106, V107, and V108.	Replace defective tubes.
	Defective crystal CR101	Replace crystal CR101.

Symptom	Probable trouble	Correction
	Tube V107 is overbiased.	Turn R116 counterclockwise until the proper voltage is obtained at pin 1.
	Pass band has shifted upwards.	Check pass band as instructed in paragraph 76.
20. Appreciable noise, hum, or other audio output besides desired responses.	Tube V107 is underbiased.	Turn R116 clockwise until proper voltage is obtained at pin 1.
	Pass band has shifted upwards.	See item 19, above.

54. Reference Symbol Numbers

The following chart lists the reference symbol number series and the subassemblies with which the reference symbol numbers are associated:

Reference symbol number series	Subchassis
100	Power supply
200	Rf tuner
300	Band-pass amplifier
400	Interpolation oscillator
500	Crystal oscillator
600	Balanced modulator
700	Main frame

55. Dc Resistance of Transformers and Coils

Transformer or coil	Terminals	Ohms
	Power supply	
T101	1–2	4.165
	3–4	4.427
	5–6	77.9
	6–7	81.7
	8–9	0
	9–10	0
	11–12	0
	12–13	0
L101	1–2	115
L102	1–2	115
T102	1–2	1,400
	3–4	190
	Rf tuner	
L201		20
L202		8.5
L203		0
L204		0
L205		1
L206		20
L207		6
L208		0
L209		0
L210		200
L211		1
L212		0
L214		0
	Band-pass amplifier	
L301		0
L302		0
L303		0
L304		0
L305		0
Z301	1–2	2.6
	3–grd	2.6
	4–grd	2.6
Z302	1–2	.7
	7–3	.7
	5–4	.7
Z303	8–4	.7
	1–2	.5
	7–3	.25
	8–3	.25
	5–4	.5
	Interpolation oscillator	
L401		0
L402		40
	Crystal oscillator	
L501		.8
L501A		1.2
L501B		2
L502		6
L701		8
T502A		3.5
T502B		1
	Balanced modulator	
T601	1–2	5.75
T602	3–4	12.25
Z602	2–4	5
	3–4	5
L601		20
L602A		0
L602B		0

56. Replacement of Parts

a. For the most part, the components of Frequency Meter FR–5/U are readily accessible and can be replaced easily if found to be faulty.

b. If any of the switch wafers requires replacement, tag the wires connected to the wafer to avoid misconnection when the new switch is installed. Follow this practice wherever replacement requires the disconnection of numerous wires.

57. Removal and Replacement of Film Mechanism

Caution: Be very careful when removing and replacing the film mechanism to prevent damage by projections from the main frame.

a. The film mechanism, mounted in the center of the equipment lower deck (fig. 29), is composed of two film reels and a gear assembly. The FINE control on the front panel is linked mechanically to the gear assembly. The film mechanism is set at the factory with precision equipment; be very careful to prevent damage to the alinement of the mechanism.

(1) Remove the drive belt from the interpolation oscillator large gear wheel (fig. 28).

(2) Remove the four retaining screws located on the bottom of the main frame holding the film mechanism.

(3) Loosen the two setscrews on the terminal block on the rear of the main frame and disconnect the two film light wires (fig. 29).

(4) Lift the film mechanism out through the rear of the main frame.

58. Disassembly and Reassembly of Film Mechanism

a. Remove the film mechanism as described in paragraph 57. Disassembly is performed as follows (fig. 26):

(1) Loosen the associated setscrews and remove the knob (1); then remove the frequency meter subassembly (2) from the front panel.

(2) Loosen the setscrews and remove the pulley (3).

(3) Remove the attaching screws and remove the film drive (4) from the frequency meter subassembly (2).

(4) Remove the attaching shoulder screw (5) and remove the lever assembly (6), pin (7), and spring (8).

(5) Loosen the setscrews and remove the cam (9) from the spur gear (11).

(6) Remove the shoulder screw (10) and remove the spur gear (11). Remove the attaching shoulder screws (12) and lever stop (13) from the drive assembly.

(7) Remove the spring (14) and the grooved pin (15).

(8) Remove the retainer ring (16) and the shaft (17).

(9) From the gear and shaft assembly, disassemble the worm gear (18), the ball bearing (19) and the gear (20). Extract the ball bearing (21).

(10) Remove the screw (22) from the film frame (23).

(11) Loosen the setscrews on the sprocket wheel (25) and remove the gear and shaft assembly (24).

(12) Remove the spacers (26 and 28) and the bearing (27)

(13) Remove the shaft (29) and the spring (30) from the roller lever assembly (31).

(14) Remove the attaching screws and the front window assembly (33) and the frame assembly (35). Remove the window (34).

(15) Remove the spring washers and the shaft (36) and the film roller (37).

(16) Remove the belt (38).

(17) Loosen the two setscrews and remove the pulley and flange assembly (39).

(18) Remove the spring washer and the shaft (40) and the film reel (41).

(19) Loosen the setscrews and remove the cover (42), and the spiral torsion spring (43) from the pulley and flange assembly (44).

(20) Remove the spring washer and the shaft (45).

(21) Remove the film reel (46).

(22) Remove the frames (47) by knocking them out with a punch.

(23) Remove the attaching screws and then the bezel (48) from the front panel.

(24) Remove the hood assembly (49) and the lens (50).

(25) Remove the terminal (51), the lamp holder (52), and the incandescent lamp (53).

b. To reassemble the film mechanism, follow the disassembly procedure in reverse order.

c. To replace the film mechanism within the main frame, proceed as follows:

(1) Turn the film strip by hand to its low end so that 00 416600 appears in the slot.

(2) Turn the COARSE tuning control to its counterclockwise extreme (lowest numbers on COARSE tuning dial).

(3) Replace the film mechanism in the main frame (fig. 29) and tighten the four retaining screws.

Caution: Do not touch capacitor C410. This adjustment is extremely critical. Any movement of this capacitor will change the entire calibration of the equipment. This is a factory adjustment only.

(4) With the CHECK control, set capacitor C402 at half mesh.

(5) With the large gear wheel on the side of the interpolation oscillator (fig. 28), set the large tuning capacitor (C403) to full mesh.

(6) With the gear wheel on the capacitor C303 shaft on the bandpass amplifier (fig. 28), set C303 to full mesh.

(7) Hook up the rubber drive belts (fig. 28); be careful to maintain the capacitor settings of the previous steps.

(8) Turn the FUNCTION SWITCH to CHECK.

(9) Turn the FINE tuning control clockwise until the TUNING METER indicates zero beat. This should occur at the first check point on the film strip. If it occurs only slightly off this point, proceed to the instructions in (11) below. If it occurs more than two readings away from the check point, proceed to the instructions in (12) below.

(10) Center the check point in the window and adjust the CHECK control so that the zero beat is again indicated. Proceed to (12) below.

(11) Remove the rubber drive belt from the film mechanism (fig. 28) and turn the film shaft so that the check point is centered in the window; then replace the drive belt. If the zero beat does not occur exactly at the check point, proceed as in (10) above.

(12) Turn the FINE tuning control clockwise and calibrate the film strip at each of the four succeeding check points as in (11) above. The film mechanism is now replaced and realined.

59. Removal and Replacement of Crystal Oscillator

a. The crystal oscillator subassembly is mounted on the left-hand side of the top deck (fig. 28), and contains a crystal unit inclosed in a temperature-controlled oven. To the rear of the oven are two frequency-divider circuits and the interpolation oscillator check circuit. To replace any part located on the underside of the crystal oscillator subchassis, first remove the subchassis from the top deck.

Item	*Name*	*Reference symbol*	*Item*	*Name*	*Reference symbol*
1	knob	O701	28	spacer	
2	frequency meter subassembly	O831	29	shaft	O837
3	pulley	O832	30	spring	O805
4	drive, film	O833	31	lever assembly, roller	O838
5	shoulder screw		33	front window assembly	
6	lever assembly	O834	34	window	H802
7	pin		35	frame assembly	
8	spring	O836	36	shaft	O840
9	cam	O804	37	roller, film	O810
10	shoulder screw		38	belt	O811
11	gear, spur	O803	39	pulley and flange assembly	O841
12	shoulder screw		40	shaft	O842
13	lever stop		41	reel, film	O829
14	spring		42	cover	
15	grooved pin		43	spring, spiral torsion	O843
16	retainer ring		44	pulley and flange assembly	O844
17	shaft	O835	45	shaft	
18	worm gear		46	reel, film	O829
19	ball bearing		47	frame	A802
20	gear	O813	48	bezel	O723
21	ball bearing	O816	49	hood assembly	
22	screw		50	lens	
23	film frame		51	terminal	
24	gear and shaft assembly		52	lamp holder	X1704
25	sprocket wheel	O836	53	lamp, incandescent	I704
26	spacer				
27	bearing	O823			

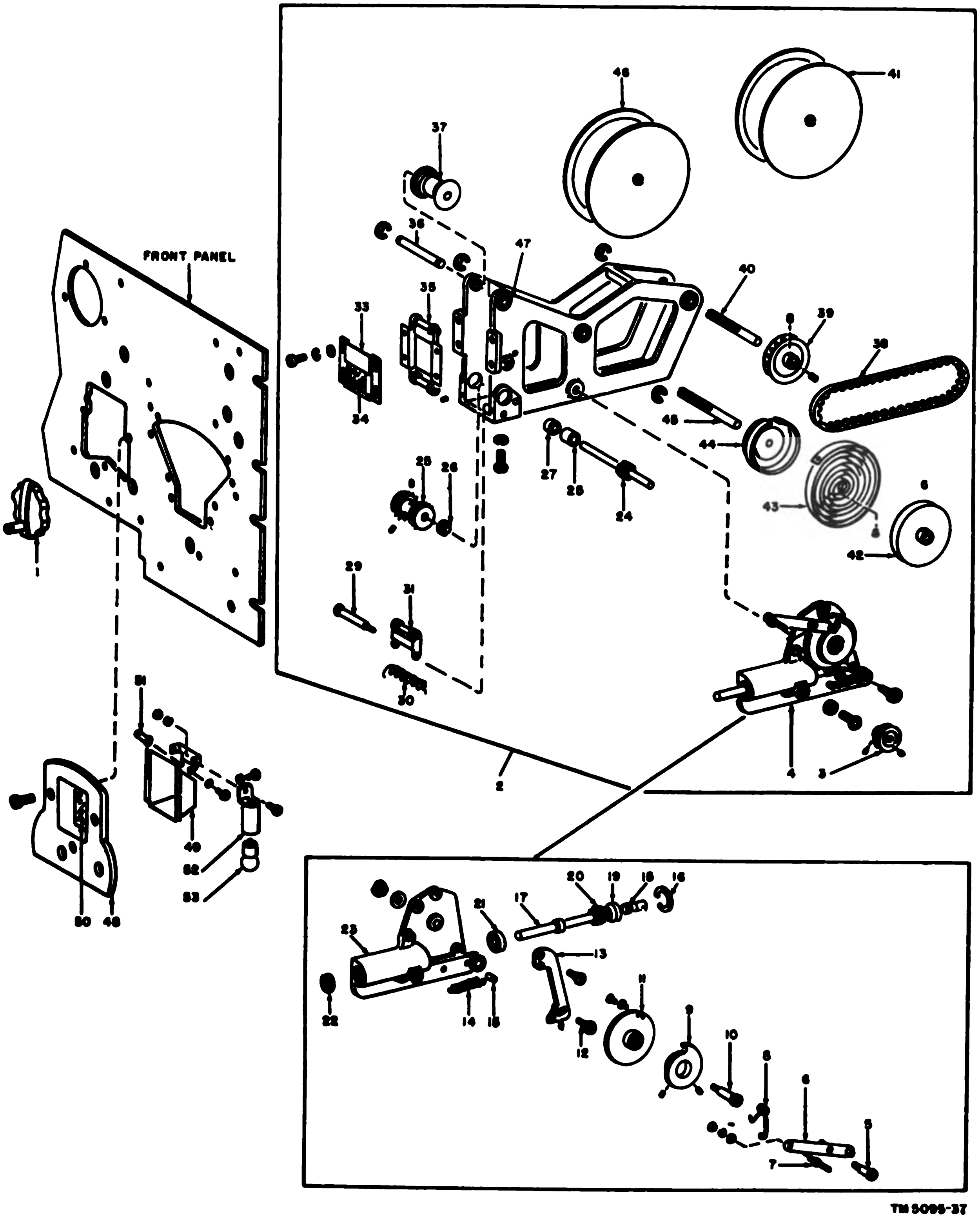


Figure 26. Film mechanism assembly, exploded view.

(1) Remove the front panel rf jack J702 by taking out the four retaining screws.

(2) Pull out P602 from J602 (fig. 28).

(3) Pull out P501 from J501 (fig. 28).

(4) Remove the four retaining screws, two on each long side of the subchassis.

(5) The crystal oscillator subchassis can now be removed.

b. To replace and firmly secure the crystal oscillator subchassis to the main frame proceed as follows:

(1) Place the crystal oscillator in the main frame.

(2) Replace the four retaining screws.

(3) Replace the front panel rf jack J702.

(4) Reconnect P602 to J602.

(5) Reconnect P501 to J501.

60. Removal, Replacement, and Disassembly of Rf Tuner and Drive Assembly

a. The rf tuner subassembly (fig. 27) is mounted on the right side of the main frame and consists of three similar circuits, one for each of the three bands. A four-gang variable capacitor, mounted on the top of the chassis, is adjusted by the COARSE tuning control. All circuit adjustments are located at the side of the variable capacitor and can be adjusted from the top of the chassis, or bottom of the main frame. To replace any of the components located on the bottom of the chassis, the subassembly must be removed from the main frame. Three coaxial cables and one coaxial jack interconnect the associated portions of the equipment with the rf tuner.

(1) Turn the FINE tuning control to 00 416000.

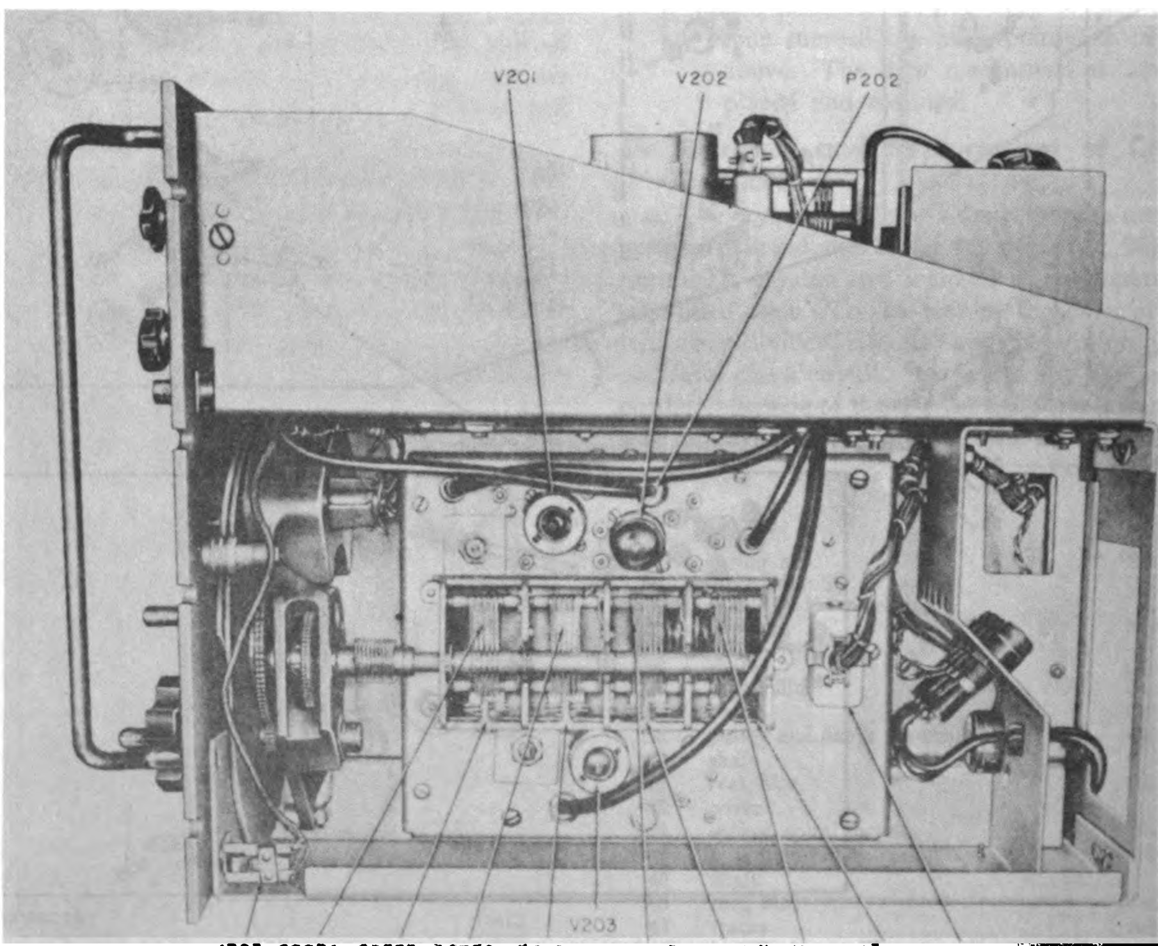


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Figure 27. Frequency Meter FR–6/U, rf tuner, location of parts, top view.

(2) Turn the COARSE tuning control to its extreme clockwise position.

(3) Remove plug P201 from J201.

(4) Loosen the setscrews holding the coupling unit to the main shaft of the four-gang variable capacitor.

(5) Disconnect the four coaxial cables.

(6) Pull the coaxial cable through the opening in the top of the chassis.

(7) Remove the four retaining screws, one located in each corner.

(8) Holding the tuner with one hand, move it horizontally until the shaft clears the coupling; be careful not to damage the shaft. The rf tuner can now be removed from the chassis.

b. When the rf tuner is removed as described above, the drive assembly can be disassembled. Refer to figure 30 and proceed as follows:

(1) Remove the bezel (1) by removing its attaching screws.

(2) Remove the bezel glass (2).

(3) Loosen the set screws and remove the knob (3).

(4) Remove the dial control (4) from the front panel by removing its attaching screws.

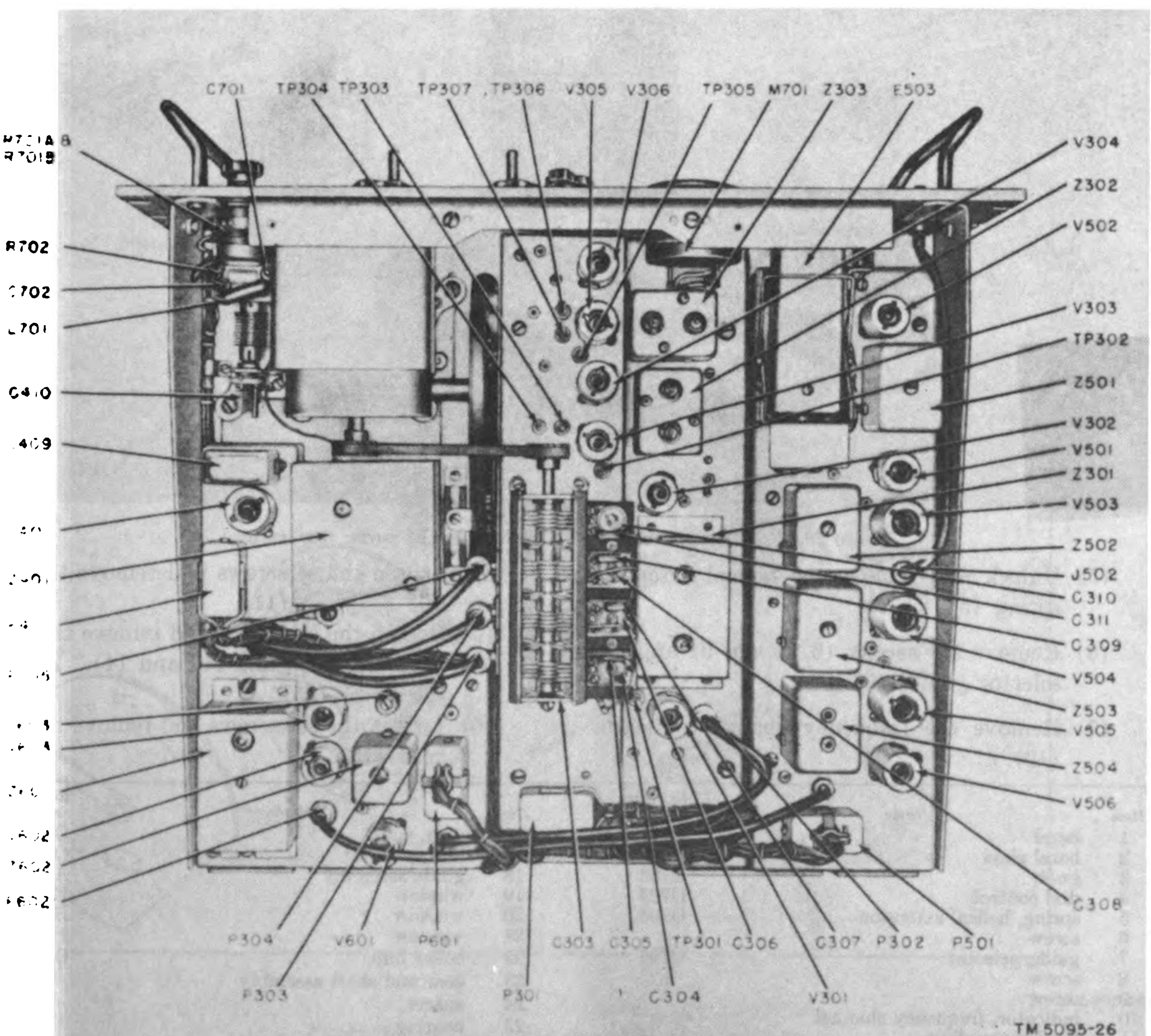

Figure 28. Frequency Meter FR-5/U, location of parts, top view.

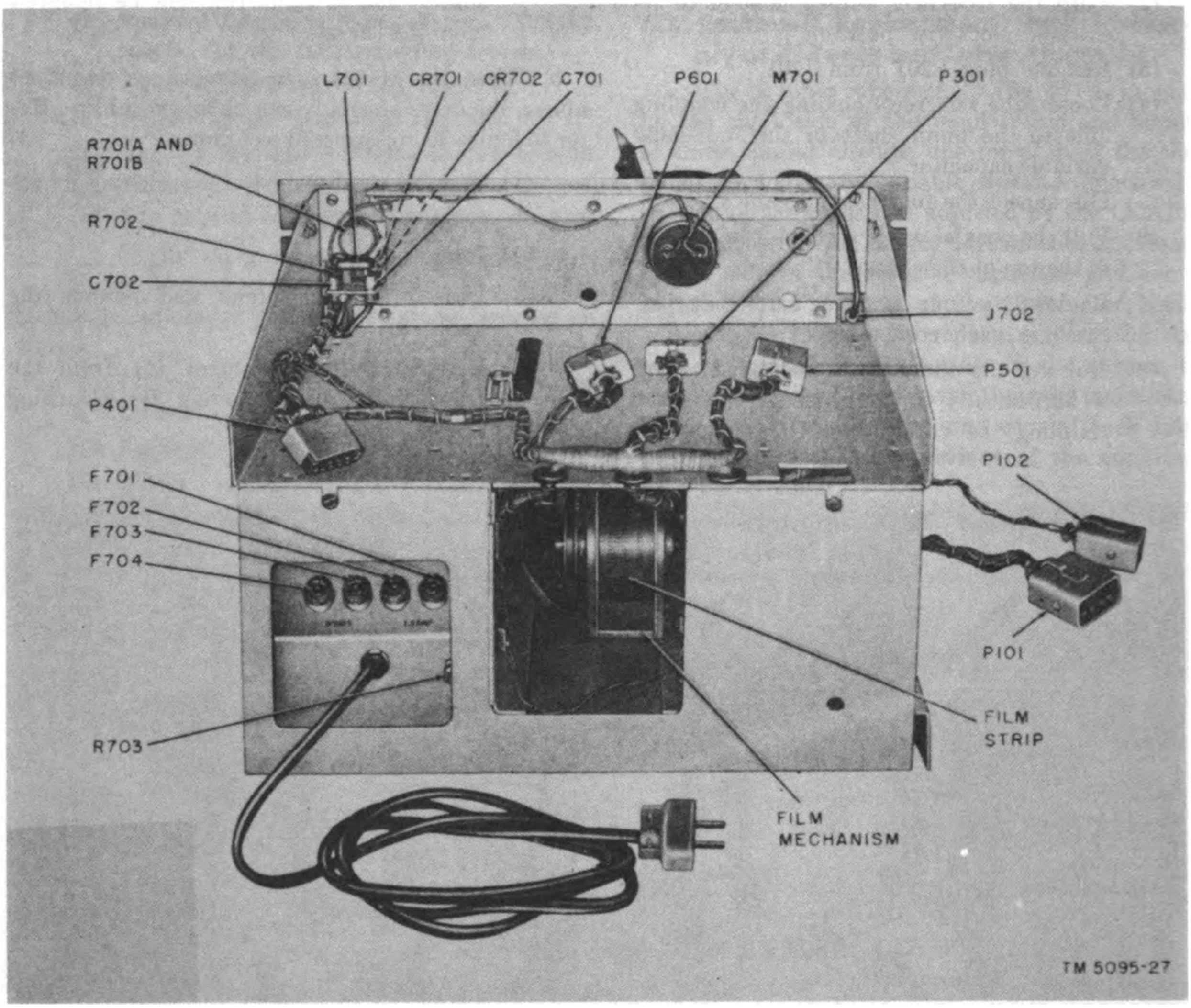

Figure 29. Frequency Meter FR–5/U, location of parts, rear view.

(5) Unlock and remove the helical extension spring (5).

(6) Remove the screws (6, 8, and 9) and the selector guides (7).

(7) Remove the frequency channel indicator (10).

(8) Loosen the setscrews and remove the flexible coupling (11).

(9) Loosen the setscrews and remove the shaft (12) and the gears (13 and 14). Remove the spring (15).

(10) Loosen the set screws and remove the spur gear (16).

Item	*Name*	*Reference symbol*	*Item*	*Name*	*Reference symbol*
1	bezel	O701	16	gear, spur	O702
2	bezel glass	H705	17	dial, control	O708
3	knob	O703	18	guide assembly	A702
4	dial control	O704	19	window	H702
5	spring, helical extension	O705	20	window	H704
6	screw		21	window	H703
7	guide, selector	O706	22	collar hub	O709
8	screw		23	gear and shaft assembly	
9	screw		24	spacer	
10	indicator, frequency channel		25	bearing	
11	flexible coupling		26	bearing	
12	shaft		27	dial assembly	A701
13	gear		28	lamp holder assembly	
14	gear		29	lamp holder	XI701
15	spring				

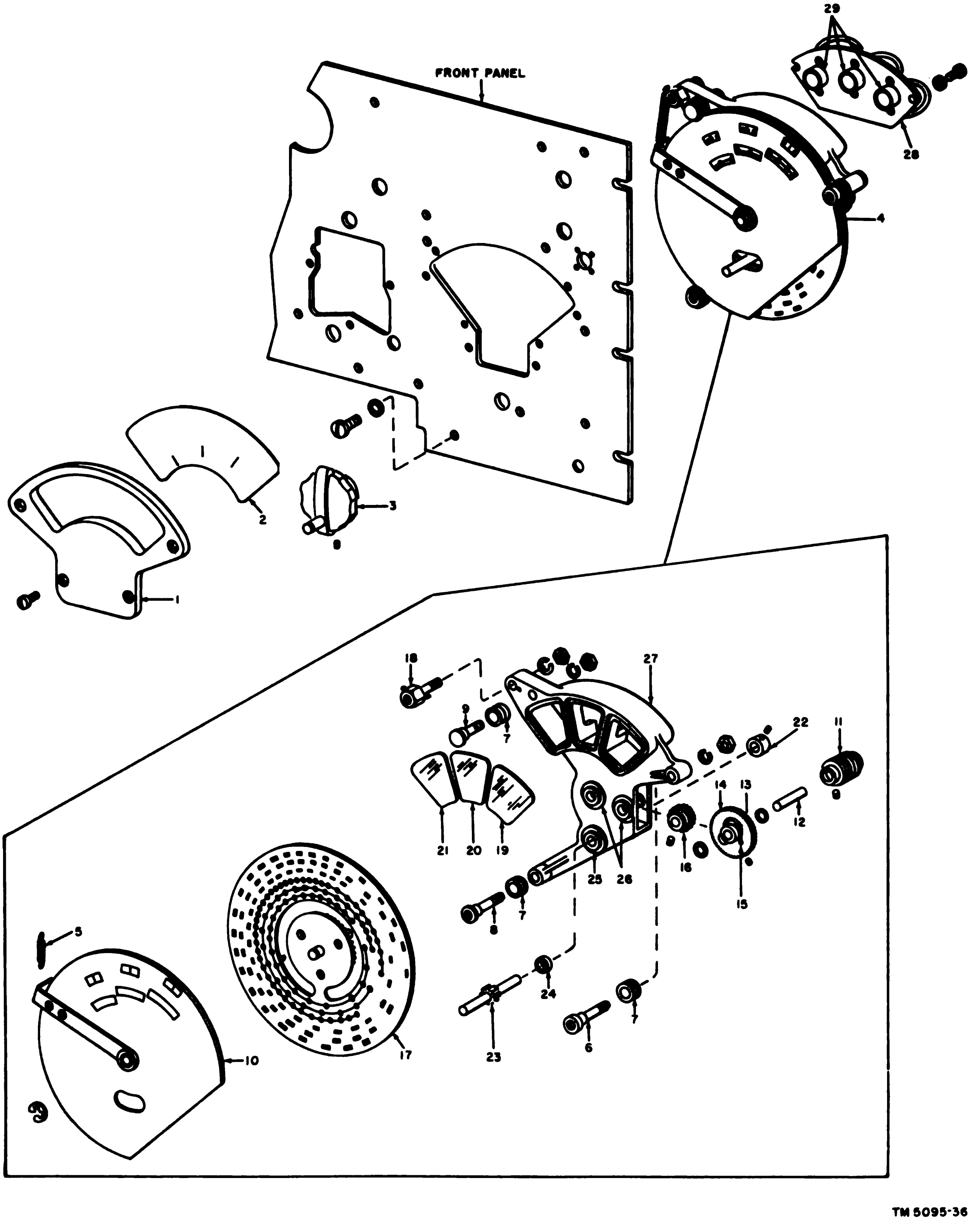

Figure 30. Rf tuner drive assembly, exploded view.

(11) Remove the control dial (17).

(12) Remove the guide assembly (18).

(13) Remove the windows (19, 20, and 21).

(14) Loosen the setscrews and remove the collar hub (22).

(15) Remove the gear and shaft assembly (23) and the spacer (24).

(16) Remove the bearings (25 and 26) with a suitable bearing puller from the dial assembly (21).

(17) Remove the lamp holder assembly (28) from the dial assembly (4).

(18) Remove the attaching screws and remove each of the three lamp holders (29).

c. Reassemble the rf tuner drive assembly in the reverse order of disassembly.

d. To replace the rf tuner on the chassis, proceed as follows:

(1) Fit the main shaft into the mechanical coupling between the two shafts. Be sure that the main tuning capacitor is fully meshed.

(2) Replace the four retaining screws.

(3) Reconnect the four coaxial cables. The rf tuner is now secured to the chassis.

61. Removal and Replacement of Power Supply

a. The power supply subassembly (figs. 22 and 31) contains, in addition to the power supply, an audio oscillator and an audio amplifier. The power supply chassis is mounted on the lefthand side of the equipment, between the upper and lower decks. The subassembly is mounted so that all pluck-out parts are readily accessible from the side of the chassis.

(1) Remove plug P101 from J101.

(2) Remove plug P102 from J102.

(3) Remove the eight retaining screws, four located on each long side.

(4) Lift out the power supply.

b. To replace and securely mount and connect the power supply on the chassis, proceed as follows:

(1) Set the power supply in position and secure it with the eight retaining screws.

(2) Reconnect plug P101 to J101.

(3) Reconnect plug P102 to J102.

62. Removal and Replacement of the Band-pass Amplifier

a. This subassembly, located on the top deck of the main frame (fig. 28), consists of three circuits, each designed to pass a selected frequency. The frequency passed is determined by the setting of the RANGE control. Most trimmers and adjusting screws are located on top of the band-pass amplifier chassis. To test or remove any component located on the bottom of the chassis, the subassembly must be removed from the main frame. Four screws secure the subassembly to the main frame. A coaxial cable interconnects the band-pass ampli-

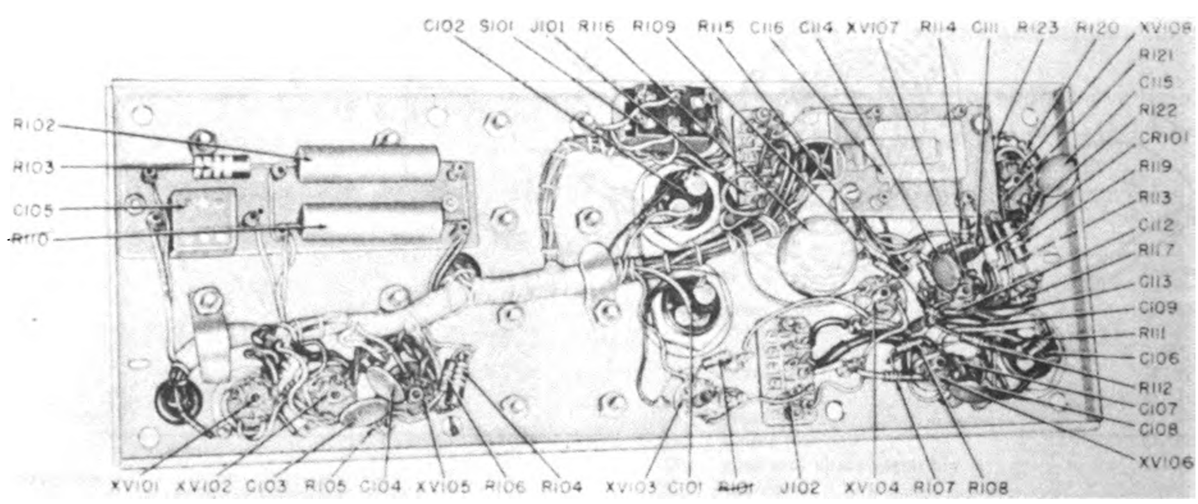

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Figure 31. Frequency Meter FR–5/U, power supply, location of parts, bottom view.

fier subassembly with the balanced modulator. The FINE tuning control tunes the first band-pass circuit through a gear- and belt-driven assembly, which also tunes the interpolation oscillator circuits.

(1) Remove the belt from the pulley.
(2) Remove plug P301 from J301.
(3) Disconnect the four coaxial cables.
(4) Remove the four retaining screws, one located in each corner.
(5) Lift out the band-pass amplifier chassis; be careful not to damage the TUNING METER.

b. To replace and secure the band-pass amplifier to the chassis, proceed as follows:

(1) Position the band-pass amplifier in the main frame.
(2) Replace the four retaining screws.
(3) Turn the FINE control so that 00 416000 appears in the film window.
(4) Turn the plates of tuning capacitor C303 to exactly full mesh.
(5) Replace the drive belt on the capacitor shaft.
(6) Reconnect plug P301 to J301.
(7) Reconnect the four coaxial cables.

63. Removal and Replacement of Interpolation Oscillator

a. This subassembly, mounted in the front right corner of the top deck (fig. 28) of the main frame, is tuned by the FINE and CHECK controls. All critical components affected by humidity are located within the hermetically sealed unit, Z401. Power and all control voltages are supplied through jack J401, located on the rear of the chassis.

(1) Remove the CHECK control by loosening the two setscrews.
(2) Remove the rubber belt between the interpolation oscillator and variable capacitor C303 on the band-pass amplifier subassembly.
(3) Remove the rubber belt between the film drive and the large gear on the interpolation oscillator.
(4) Remove plug P401 from J401.
(5) Remove the three retaining screws.
(6) Lift the interpolation oscillator off the main frame.

b. To replace the interpolation oscillator subassembly, proceed as follows:

(1) Place the interpolation oscillator on the main frame.
(2) Replace the three retaining screws.
(3) Turn the FINE control so that 00 416000 is centered in the film window.
(4) Turn the COARSE control to its counterclockwise extreme (lowest numbers on the COARSE tuning dial).
(5) Replace the rubber drive belt on the large gear wheel that drives C403.
(6) Turn the rotor of capacitor C303 to exactly full mesh.
(7) Replace the rubber drive belt on the shaft of C303.
(8) Reconnect P401 to J401.
(9) Recalibrate the interpolation oscillator to the film strip as instructed in paragraph 58c.

64. Removal and Replacement of Balanced Modulator

a. The balanced modulator subassembly is mounted in the right rear corner of the top deck (fig. 28). For proper alinement of the circuits, the chassis must be removed from the top deck.

(1) Disconnect P601 from J601.
(2) Disconnect P602 from J602.
(3) Disconnect P302 from J302.
(4) Remove the four retaining screws, one located in each corner.
(5) Carefully lift the balanced modulator from the chassis.

b. To replace, connect, and mount the balanced modulator chassis, proceed as follows:

(1) Place the balanced-modulator chassis on the main frame.
(2) Replace the four retaining screws.
(3) Reconnect P601 to J601.
(4) Reconnect P302 to J302.
(5) Reconnect P602 to J602.

Section III. CALIBRATION AND ALINEMENT

65. Test Equipment Required for Calibration and Alinement

The items of test equipment required for the calibration and alinement of Frequency Meter FR-5/U are the same as those used for troubleshooting (par. 50).

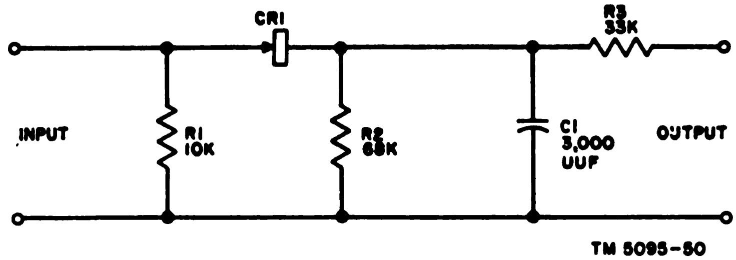

Figure 32. Recommended demodulator schematic diagram.

66. Band-Pass Amplifier

a. Overall Check. To determine whether alinement of the band-pass amplifier is necessary, perform the following overall check. First, place the frequency meter into operation, allow a warmup period of at least 5 minutes, and set the FUNCTION SWITCH to FINE.

(1) Set the RANGE switch to 10–21.7 MC.

(*a*) Connect the multimeter to output jack J303 on the band-pass amplifier; use a cable 4 inches long.

(*b*) Tune the interpolation oscillator FINE tuning control over the entire range; watch the multimeter indication.

(*c*) The multimeter should not read less than 75 volts at any frequency.

(2) Set the RANGE switch to 21.7–46.7 MC.

(*a*) Remove the multimeter from J303 and connect it to jack J304.

(*b*) Tune the interpolation oscillator FINE tuning control over the entire range.

(*c*) The multimeter should not read less than 35 volts at any frequency.

(3) Set the RANGE switch to 46.7–100 MC.

(*a*) Remove the multimeter from J304 and connect it to J305.

(*b*) Tune the interpolation oscillator FINE tuning control over the entire range.

(*c*) The multimeter should not read less than 25 volts at any frequency.

Note. If band 1 fails to meet the above requirements, check the input voltage at jack J302. The minimum signal input voltage reading should be 5 volts. If any range fails to meet the above requirements, replace the tubes used in that band and repeat the test check. If the output still fails to meet the requirements, alinement is required. Follow the procedure outlined in *b* below for alinement of the band-pass amplifier.

b. Band-Pass Amplifier Alinement. The procedure for alinement of the band-pass amplifier on all three ranges of operation is given below. The test equipment required for alinement is listed in paragraph 65. In addition, the following components are necessary: Nonmetallic alinement screw driver; 1,000-ohm resistor, 1 watt.

(1) *Alinement of RANGE 10–21.7 MC.* The following steps are used when alining Z301 on band 1. Before proceeding, set variable capacitor C303 (fig. 28) to the center of the capacitor range.

(*a*) Set the POWER switch to the on position.

(*b*) Set the RANGE switch to 10–21.7 MC.

(*c*) Connect the 1,000-ohm resistor in series with the signal (marker) generator and J302 (fig. 33).

(*d*) Connect the sweep generator output to J302. Connect the sweep signal from the sweep generator to the horizontal input of the oscilloscope.

(*e*) Connect the demodulator probe to TP301 (fig. 28) and the output of the demodulator to the vertical input of the oscilloscope.

(*f*) Set the signal generator at 425.2 kc. Check with a frequency meter standard and make corrections if necessary.

(*g*) Set the sweep generator to its center frequency of 425.2 kc using a ±15-kc sweep width.

(*h*) Short terminal 7 of Z301 (fig. 33) or the stator of C303B to ground.

(*i*) Tune C304 (fig. 28) to maximum output at the marker frequency. See A, figure 34 for a typical curve.

(*j*) Remove the short as indicated in (*h*) above and short terminal 8 of Z301 (fig. 28) or the stator of C303C to ground.

(*k*) Tune C306 (fig. 28) to dip at the signal generator frequency. See B, figure 34 for a typical curve.

(*l*) Remove the short indicated in (*j*) above and short the C303B stator or pin 3 of

Z301 (fig. 28) to ground. Adjust C308 to maximum amplitude at the signal generator frequency. See C, figure 34 for a typical curve.

(*m*) Remove the short indicated in (*l*) above and adjust C310 for a dip at the signal generator frequency. See D, figure 34 for a typical curve.

(*n*) Remove the demodulator probe from TP301 and connect it to J303 (fig. 33).

(*o*) Vary the capacitance of C304 and C310 (fig. 28), if required, to produce a symmetrical response about the signal generator frequency. See E, figure 34 for a typical curve.

Caution: Be very careful to avoid disturbing variable capacitor C303 during these adjustments.

(2) *Alinement check procedure for Z301.* After alining Z301, follow the test procedure below to determine whether it has been adjusted correctly.

(*a*) Connect the signal generator between J302 (fig. 33) and ground.

(*b*) Connect 4 inches of RG–58/U coaxial cable from J303 (fig. 33) to the rf voltmeter.

(*c*) Tune the signal generator through the range of 416.6 to 434 kc with a 2-volt output signal. Keep the output at maximum with variable capacitor C303 (fig. 28). Monitor the signal with a frequency meter at the band edges to be certain of adequate output at all frequencies.

(*d*) With 2 volts input to the band-pass amplifier, the output voltage at J303 should not be less than 75 volts at any frequency.

(3) *Adjustment of capacitor C312* (fig. 33). With the signal generator connected as indicated in (2) (*a*) above and the rf voltmeter as in (2) (*b*) above, follow the procedure outlined below to adjust the 400-kc rejection.

(*a*) Set variable capacitor C312 to maximum capacitance.

(*b*) Set the signal generator frequency to 400 kc (as checked by the frequency meter standard), and adjust the signal generator output to 1 volt.

(*c*) Set the multimeter to the proper range and, using a nonmetallic tuning tool for adjustment, adjust wires of C312 to provide a minimum output, approximately 5 millivolts (mv). The adjustment is very critical as the capacitance required is only a small fraction of a micromicrofarad.

(4) *Alinement of RANGE 21.7–46.7 MC.*

(*a*) Set the POWER switch to the on position.

(*b*) Set the RANGE switch to 21.7–46.7 MC.

(*c*) Connect the sweep generator and the signal generator output to TP 302 (fig. 28) with a 1,000-ohm resistor in series with the signal generator hot lead. Connect the sweep signal from the sweep generator to the horizontal input of the oscilloscope.

(*d*) Connect the demodulator probe to TP304 (fig. 28) and the output of the demodulator to the vertical input of the oscilloscope.

(*e*) Set the signal generator to 850.4 kc. Check with the frequency meter standard and adjust the signal generator if necessary.

(*f*) Set the sweep generator to the center frequency of 850.4 kc and the sweep frequency at ±30 kc.

(*g*) Short terminal 7 of Z302 (fig. 33) to ground.

(*h*) Adjust slug *A* of Z302 to peak at the signal generator frequency. See F, figure 34, for a typical curve.

(*i*) Remove the short from terminal 7 and short terminal 8 of Z302 to ground.

(*j*) Adjust slug *B* to dip at the signal generator frequency. See G, figure 34, for a typical curve.

(*k*) Remove the short from terminal 8 and short terminal 5 of Z302 (fig. 33) to ground. Adjust slug *C* to peak at the signal generator frequency. See H, figure 34, for a typical curve.

(*l*) Remove the short from terminal 5 and adjust slug *D* to dip at the signal generator frequency. See I, figure 34, for a typical curve.

(*m*) Move the demodulator probe from TP304 to J304.

(*n*) Adjust slugs *A* and *D* of Z302, if required, to provide a symmetrical re-

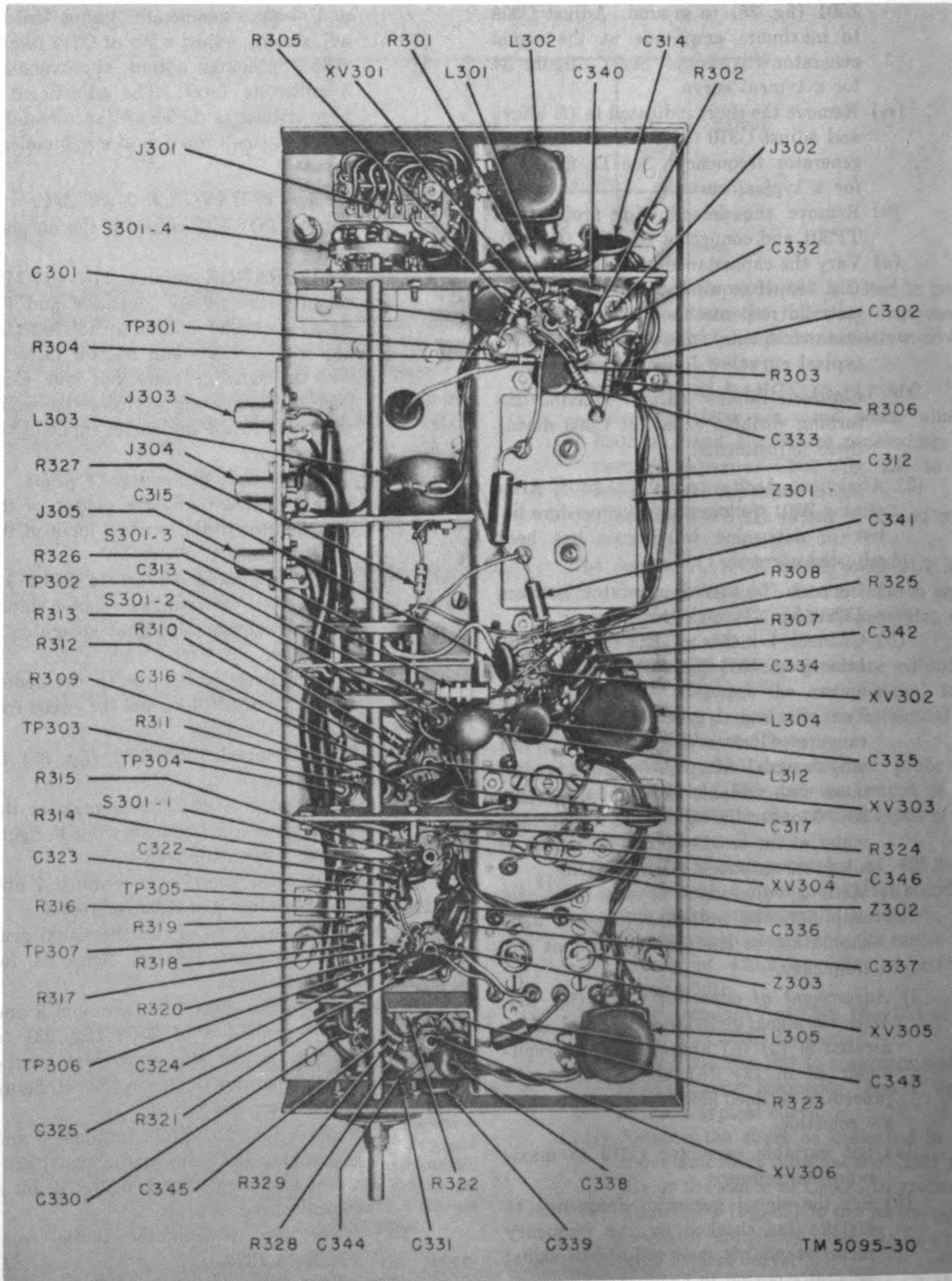

Figure 33. Frequency Meter FR–5/U, band-pass amplifier, location of parts, bottom view.

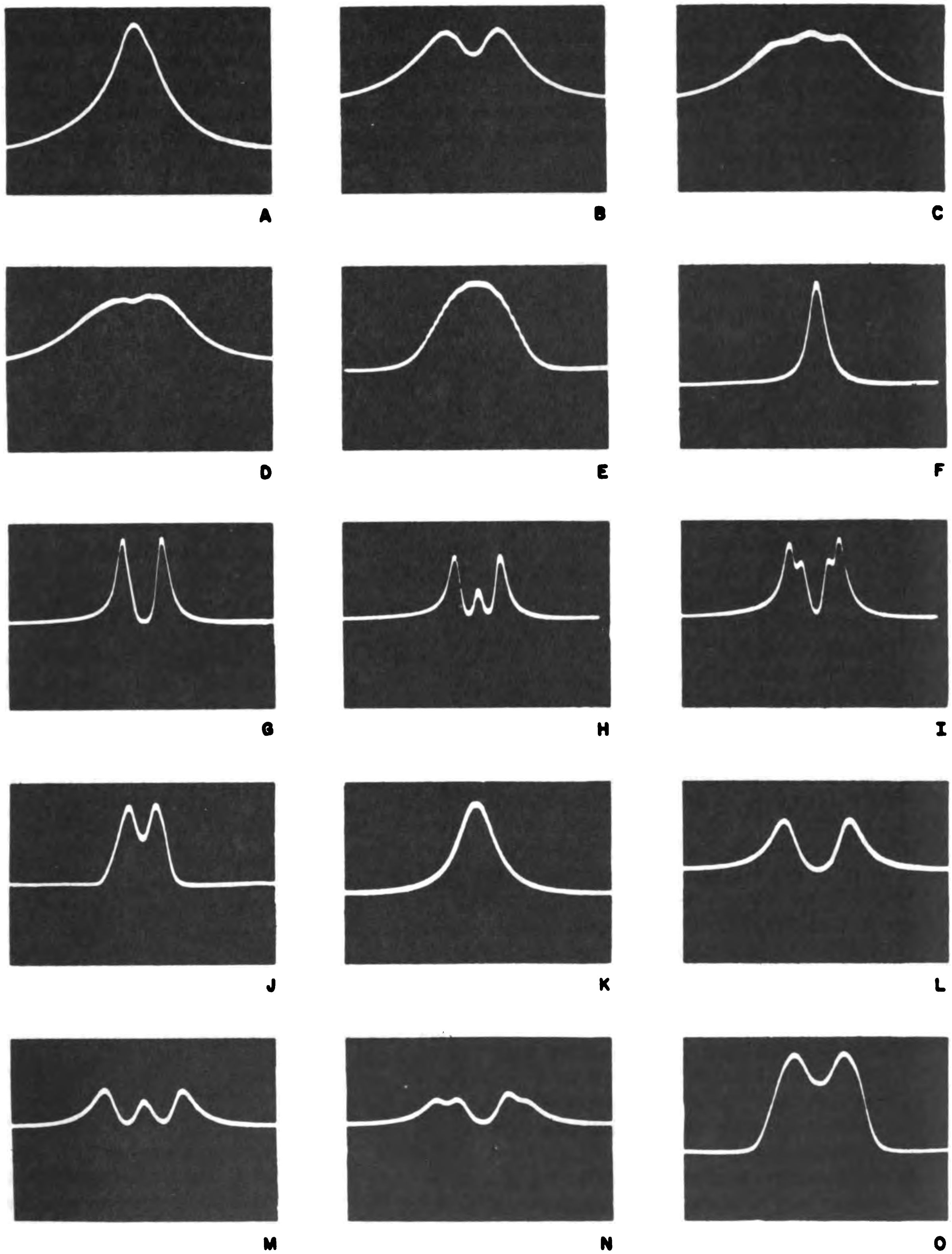

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Figure 34. Frequency Meter FR–6/U, wave forms.

sponse about the marker frequency. See J, figure 34, for a typical response curve.

(*o*) Connect the output of the signal generator to TP302 and the multimeter to J304; use a maximum of 6 inches of cable to J304.

(*p*) Tune the signal generator frequency over a range of 833.2 to 868 kc.

(*q*) Set the signal generator output to give a maximum of 10 volts at J304.

(*r*) Minimum output voltage at any frequency in the range must be 7.9 volts (2 db down).

(5) *Alinement of RANGE 46.7–100 MC.*

(*a*) Connect the sweep generator and marker generator outputs to TP305 (fig. 28) with a 1,000-ohm resistor in series with the marker generator hot lead. Connect the sweep signal from the sweep generator to the horizontal input of the oscilloscope.

(*b*) Connect the demodulator probe to TP307 (fig. 28) and the output of the demodulator to the vertical input of the oscilloscope.

(*c*) Set the marker generator to 1,700.8 kc. Check with the frequency meter if necessary.

(*d*) Set the sweep generator to 1,700.8 kc and the sweep frequency at ±60 kc.

(*e*) Short terminal 7 of Z303 (fig. 33) to ground.

(*f*) Adjust slug *A* of Z303 for maximum output at the marker frequency. See K, figure 34, for a typical curve.

(*g*) Remove the short from terminal 7 and short terminal 8 of Z303 to ground.

(*h*) Adjust slug *B* for a dip at the marker frequency. See L, figure 34, for a typical curve.

(*i*) Remove the short from terminal 8 and short terminal 5 of Z303 to ground.

(*j*) Adjust slug *C* for a peak output at the marker frequency. See M, figure 34, for a typical curve.

(*k*) Remove the short from terminal 5 and adjust slug *D* for a dip at the marker frequency. See N, figure 34, for a typical curve.

(*l*) Remove the demodulator probe from TP307 (fig. 28) and connect it to J305 (fig. 33).

(*m*) Adjust slugs *A* and *D* of Z303 (fig. 33), if required, to provide a symmetrical response about the signal generator frequency. See O, figure 34, for a typical response curve.

(*n*) Connect the signal generator output to TP305 (fig. 28) and the multimeter to J305.

(*o*) Set the output of the signal generator to produce 10 volts output at J305 (fig. 33).

(*p*) Tune the signal generator frequency over the range of 1,666.4 to 1,736 kc. The minimum output voltage should be 7.9 volts (2 db down).

(6) *Final check.* To final check the band-pass amplifier, repeat the band-pass amplifier alinement overall check (*a* above).

(7) *Alternate method of band-pass amplifier alinement.*

(*a*) When no sweep generator is available, the following alinement procedure may be used. It is much more difficult than the visual alinement procedure described in (5) above.

(*b*) Band-pass networks Z301, Z302, and Z303 may be tuned by applying a signal of the center frequency only to J302 (fig. 33), TP302, and TP305 (fig. 28), and measuring the output voltage at TP301, TP304, and TP307 (fig. 28), respectively. With the appropriate terminal shorted as stated in the alinement procedure in (5) above, slug *A* should be adjusted for a maximum output voltage, slug *B* for a minimum, slug *C* for a maximum, and slug *D* for a minimum.

67. Balanced Modulator Alinement

To aline the balanced modulator circuit properly, proceed as instructed below. T-Junction Connector UG–274/U, 6 inches of cable, a radio receiver, a 30-db pad, and a dc vacuum-tube voltmeter are necessary.

a. To test the input and output circuits, follow the procedure outlined below in the order given; use the test equipment mentioned above.

(1) Remove the retaining screws from the balanced modulator to get at the adjustments beneath the chassis. Leave connections intact except as stated below.

(2) Disconnect the crystal oscillator cable plug P602 (fig. 28) from J602.
(3) Connect one end of the T-junction connector to J602 and the plug from the crystal oscillator to the other end of the T.
(4) Connect the multimeter to the remaining open end of the T.
(5) Set the POWER switch to the on position.
(6) The multimeter should read approximately .24 volt. If this reading is correct, continue with the procedure in (7) below. If this reading is not correct, follow the procedure outlined in *b* below.
(7) Remove the T connector and the multimeter and replace the crystal oscillator cable plug in J602.
(8) Connect the multimeter to pin 2 of J601 (fig. 28) and ground (to measure interpolation oscillator input to the balanced modulator). The voltage reading should be approximately .82 volt. Tune the interpolation oscillator over its entire range; the voltage should not vary in excess of 3 db. If this reading is correct, continue with the procedure in (9) below. If this reading is not correct, follow the procedure outlined in *b* below.
(9) Remove the multimeter connection from pin 2 of J601.
(10) Insert T-junction connector between the output cable of the balanced modulator and J302 (fig. 33) of the band-pass amplifier.
(11) Connect the open side of the T-junction connector to the multimeter with the 6-inch coaxial cable.
(12) The voltage should be approximately 5 volts minimum and 11 volts maximum as the interpolation oscillator is tuned over its entire range. If both readings are as specified above, but the output is low, change tubes and recheck. If the output is still low, alinement is necessary. Follow the instructions in *b* below.

b. Follow the procedure below when alining the balanced modulator input circuit. Allow the frequency meter to warm up for at least 5 minutes.

(1) Remove the balanced modulator output cable plug P302 from J302 on the band-pass amplifier (fig. 28) and connect the cable to the antenna terminals of the radio receiver through a 30-db attenuator.
(2) Set balance control R603 (fig. 28) to either extreme position.
(3) Remove tube V401 (fig. 35) from its socket in the interpolation oscillator.
(4) Tune the receiver to 400 kc and adjust slugs *A* and *B-C* of Z601 (fig. 28) for maximum deflection on the *S* meter on the front panel of the receiver.
(5) Adjust balance control R603 (fig. 28) for minimum output or minimum meter deflection.
(6) Replace V401 in the interpolation oscillator.

c. Follow the procedure below when alining the output circuit of the balanced modulator.

(1) Set the interpolation oscillator dial to 425 kc.
(2) Tune the receiver to 425 kc.
(3) Adjust tuning slugs *A* and *B* of Z602 (figs. 28 and 36) for maximum output or maximum deflection of the *S* meter.
(4) Disconnect the 30db attenuator from the receiver and connect an rf voltmeter to the output of the attenuator.
(5) Tune the interpolation oscillator from minimum to maximum frequency of the range and make sure that the output voltage does not fall below 5 volts throughout the range.

d. To check for undesired modulation products, follow the test procedure outlined below:

(1) Set the POWER switch to the on position.
(2) Set the oscillator (FINE tuning) dial to 416.6 kc.
(3) Connect the receiver antenna terminals in series with a 30-db attenuator pad and the output of the balanced modulator jack J603 (fig. 36).
(4) Tune the receiver for maximum output at 416.6 kc and note the output level on the receiver *S* meter.
(5) Disconnect the 30-db attenuator pad from the receiver.
(6) Connect the signal generator to the antenna terminals of the receiver.
(7) Adjust the signal generator frequency to 416.6 kc and set its output to provide the same receiver output level as that obtained in (4) above.
(8) Make a note of the signal generator output level as the desired signal output and

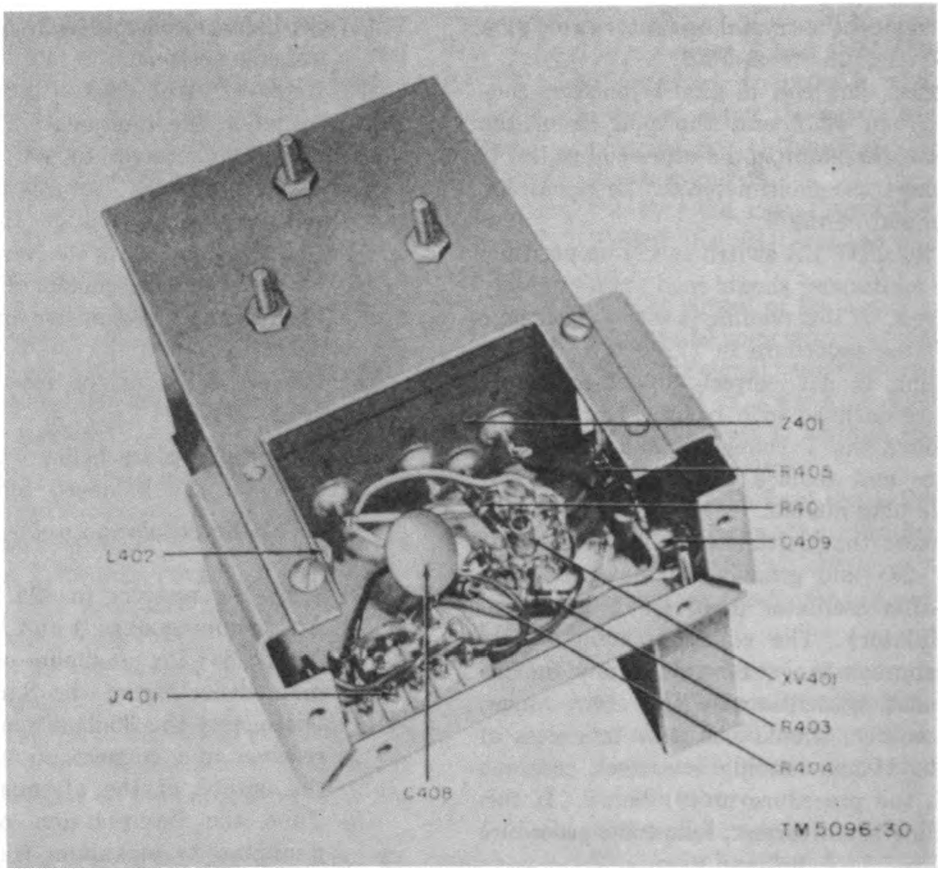


Figure 35. Frequency Meter FR–5/U, interpolation oscillator, location of parts, bottom view.

keep it for comparison with the output noted in (13) below.

(9) Reconnect the receiver input to the attenuator, which is still connected to the output of the balanced modulator.

(10) Tune the receiver to peak at 400 kc and note the receiver output level for comparison with the output noted in (14) below.

(11) Without disturbing the receiver controls, disconnect the attenuator and connect the signal generator to the receiver antenna terminals.

(12) Tune the signal generator to peak receiver output at 400 kc.

(13) Adjust the signal generator output to the level noted in (8) above.

(14) Make a note of the signal generator output level as the undesired 400-kc output.

(15) Compare the reading with that noted in (10) above, which is the desired signal output.

(16) The undesired output should be at least 40 db lower in level than the desired output.

68. Crystal Oscillator Alinement

The alinement procedures for all three circuits on the crystal oscillator chassis are given below. The following is required: a receiver with 3.6 mc in its range and that is equipped with an *S* meter; a signal at 3.6 mc or some submultiple thereof which has been compared directly to a standard signal from a primary frequency standard having an accuracy of one part in ten million, such as Frequency Meter Calibrator Set AN/URM–18; and any oscilloscope with a good response to above 400 kc.

a. Compensation for Crystal Aging. Because of the aging of the crystal, frequency correction will be necessary once a month for the first 6 months and once every 6 months thereafter. To compensate for crystal aging, proceed as follows:

(1) Connect a cable from the 3.6 MC CRYSTAL OUTPUT jack on the front

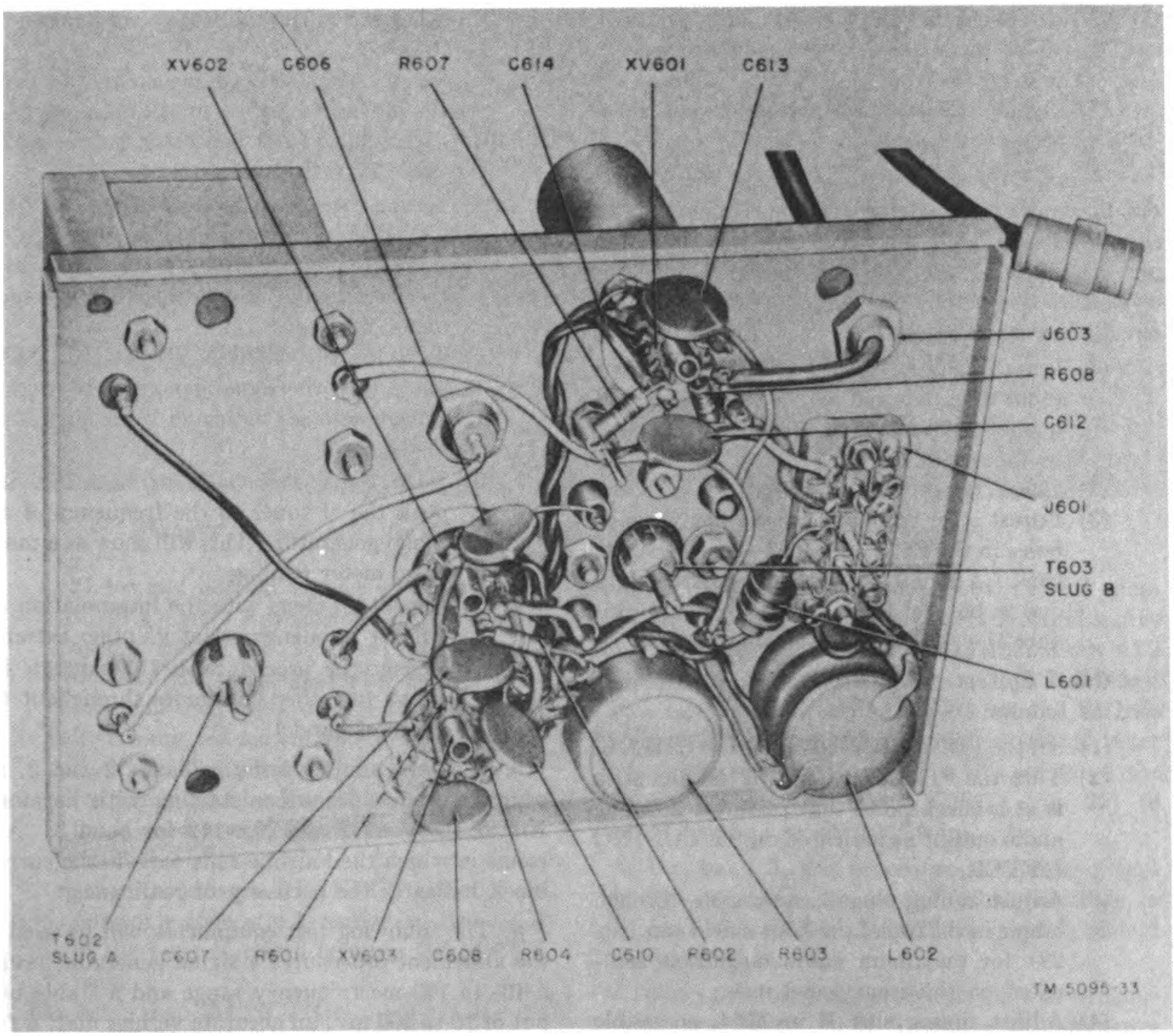


Figure 36. Frequency Meter FR–5/U, balanced modulator, location of parts, bottom view.

panel (fig. 4) to the antenna terminals of a receiver.

(2) Set the calibrator set to 3.6 mc and connect it to the receiver antenna terminals.

(3) Tune the receiver to 3.6 mc. With the receiver BFO off, a low-frequency audio tone will be heard in the headphones.

(4) Remove all screws except the lower right one from the front panel name plate (fig. 4) and pivot the plate on that screw; this exposes the 3.6 MC ADJUST control (C503).

(5) Using a fairly large screwdriver, turn this control until the frequency of the audio tone decreases. As the frequency nears zero, observe the oscillation of the *S* meter pointer on the receiver. Continue to adjust the control until the pointer ceases to move. The crystal is now operating on 3.6 mc.

b. Compensation for Changed Components. If the crystal oven unit or tube V502 is changed, more correction may be required than can be achieved by the procedure described in *a* above. In this case the procedure should be modified as follows:

(1) Remove the crystal oscillator chassis as described in paragraph 59*a*.

(2) Set 3.6 MC ADJUST to midposition. (The slot in the shaft will be in a horizontal position.)

(3) Turn variable capacitor C504, accessible

through a hole in the front of the chassis, to obtain a zero beat as described in *a* above.

(4) Replace the crystal oscillator chassis as described in paragraph 59*b*.

c. Divider Circuits. Before alining the divider circuits, check to see that the interpolation oscillator signal is present, by connecting the multimeter to pin 2 of J401. Also check the crystal oscillator as instructed in *a* and *b* above. To aline the divider circuits, proceed as follows:

(1) Connect P602 (fig. 28) to the oscilloscope input terminals and set the oscilloscope frequency at 400 kc. A circle should be seen on the screen.

(2) Check tubes V503 and V504.

(3) Adjust the trimmers accessible through holes in the Z502 and Z503 (fig. 28) shield cans. A small amount of adjustment of one or both of these trimmers should produce the right pattern on the screen.

d. Check System. To aline the check system, proceed as follows:

(1) Set the FUNCTION SWITCH to CHECK.

(2) Turn the FINE control until the film strip is at a check point that produces a strong audio output as indicated on the TUNING METER.

(3) Adjust tuning slug *A*, accessible through a hole in the top of the Z504 shield can (fig. 28) for maximum audio output as indicated on the front panel meter.

(4) Adjust tuning slug *B* in Z504, accessible from the underside of the chassis (fig. 37) for maximum output.

(5) Adjust tuning slug *C* in Z504, accessible from the underside of the chassis, for maximum output.

69. Rf Tuner Alinement

a. If the harmonic indicating system shows incorrect readings because of improper positioning of the movable hairline after the correct operating procedure has been followed, and the mechanical operation of the system is correct, realinement of the rf tuner is required.

b. After any repairs have been made in the rf tuner chassis, make the following tests to determine whether realinement is necessary on band 1.

(1) Set the interpolation oscillator frequency at one extreme as indicated by one or the other end of the calibration columns on the film.

(2) Set the COARSE tuning control to cause the movable hairline to fall on block 24.

(3) Connect a signal generator between J202 (fig. 27) and the chassis.

(4) With the FUNCTION SWITCH on COARSE, tune the signal generator to the same frequency as the rf tuner, as indicated first by a fluctuating, then a steady, meter reading.

(5) Turn the FUNCTION SWITCH to FINE and adjust the signal generator to produce a beat note, as indicated by a fluctuating meter needle.

(6) Turn the switch back to COARSE and peak the rf tuner to the frequency of the signal generator. This will show as a maximum meter reading.

(7) Repeat all steps with the interpolation oscillator frequency set at its other extreme.

(8) Repeat the procedure in (1) through (5) above for other harmonics throughout the range of band 1.

c. To make similar tests on bands 2 and 3, repeat the above procedure starting with harmonic No. 52 for band 2 and No. 112 for band 3. Any result in which the hairline falls outside the correct block indicates the necessity of realinement.

d. The following test equipments will be used in the alinement procedure: a signal generator having a 10- to 100-mc frequency range and a stable output of 10 to 100 mv; an accurate vernier dial; a frequency standard having a 1-mc output accurate to $\pm$.01 per cent, and a harmonic generator that can provide 10 mv of signal every megacycle from 1 mc to 100 mc. If the frequency standard can provide 30-root-mean-square (rms) volts of signal, the harmonic generator is not required.

e. Two types of realinement procedures are applicable to the rf tuner. One of these is used only when the circuit shunt capacitances have been disturbed, and the other is used when there has been a change in inductance, as when the coil has been changed. When the inductance has not changed, proceed as follows:

(1) Set the FR-5/U internal signal to 425 kc by turning the FINE tuning control until this reading appears in the window.

(2) Set the signal generator to 21.25 mc; use the frequency meter standard to set it to

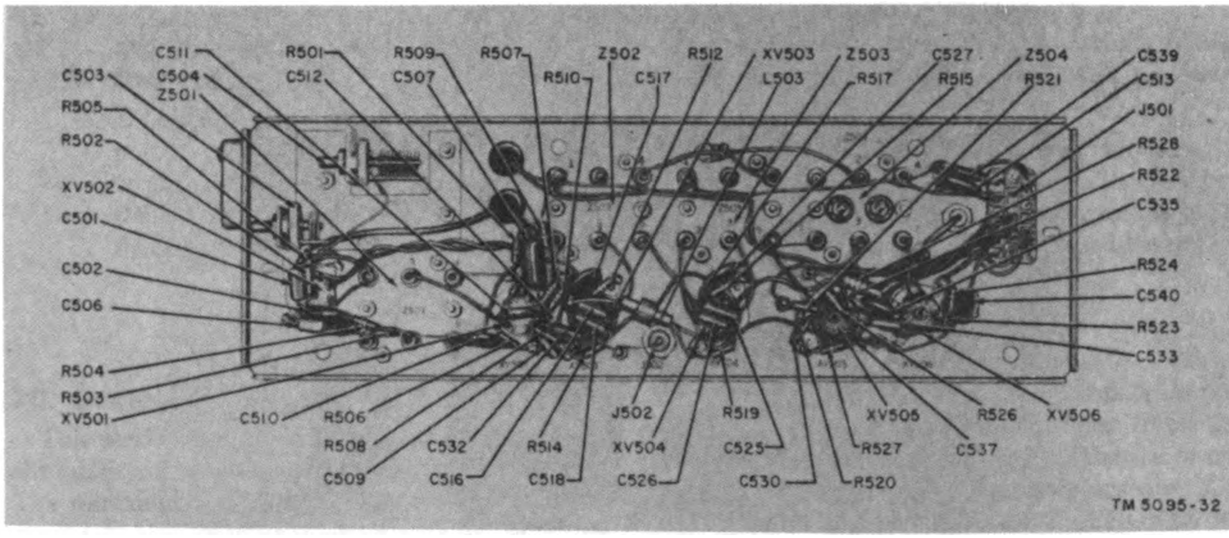


Figure 37. Frequency Meter FR–5/U, crystal oscillator, location of parts, bottom view.

21 mc and its own vernier dial to bring it to 21.25 mc. Any mixer-audio amplifier system can be used to detect the beat note between the signal generator and the harmonic of the standard basic frequency, but it is more convenient to use the FR–5/U itself for this purpose. If a combination frequency standard and harmonic generator is used, use a T-junction connector to inject this signal and that from the signal generator into the RF INPUT jack. If no harmonic generator is used, feed the signal of the 1-mc standard into the RF INPUT jack.

(3) Set the FUNCTION SWITCH to COARSE and tune the rf tuner to the frequency of the signal generator.

(4) Set the FUNCTION SWITCH to FINE and tune the signal generator slightly to produce a beat note.

(5) Turn the FUNCTION SWITCH back to COARSE and readjust the FR–5/U rf tuner to put the movable hairline in the middle of harmonic No. 50.

(6) Adjust band 1 trimmer capacitor C207B (fig. 38) to cause the tuning meter to indicate a maximum reading.

f. If the tuned circuit inductance has not changed, band 1 now is alined correctly. The tests described above should be performed carefully to assure correct alinement.

g. For band 2, proceed as in *e* above, changing the generator frequency to 45.9 mc, which is the middle of the 108th harmonic. Set the signal generator to 45.9 mc by using the standard signal source and the vernier dial, to produce approximately 45.9 mc, and then a beat note with the FR–5/U internal signal for the exact setting. Next, set the FUNCTION SWITCH to COARSE and set the rf tuner to put the harmonic hairline in the center of the 108th harmonic, and adjust C207D (fig. 27) to peak the tuned circuit to 45.9 mc.

h. For band 3, the procedure is similar except that 98.6 mc, the center of the 232nd harmonic, is used, and both C207F and C207H (fig. 27) should be adjusted.

i. When the foregoing procedure fails to produce satisfactory results, or if a change in inductance is known to have taken place, a simple correction of shunt capacitance is not sufficient to realine the rf tuner. For this condition, *j* through *l* below provide a guide to the method required.

j. The rotor plates of C207A, C207C, C207E, and C207G (fig. 27) were designed to provide the correct frequency-versus-rotation characteristic when shunted by certain specific values of capacitance. The ratio of high to low frequency coverage that can be achieved with this capacitor is a function of the shunt capacitance; therefore, when this ratio is correct, it is known that the shunt capacitance is correct. The first step in the alinement procedure is to adjust the trimmer capacitors to produce the correct frequency ratio. When this has been done, it is necessary only to adjust the coils to achieve the correct frequency at one dial setting and the entire curve will be correct.

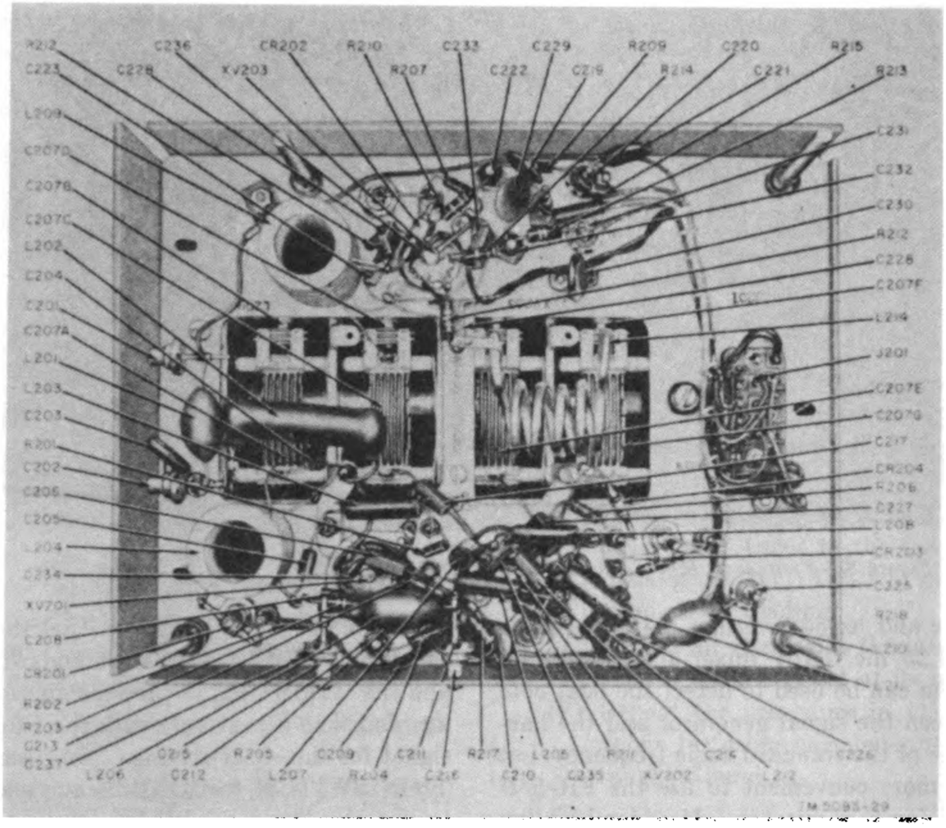


Figure 38. Frequency Meter FR–5/U, rf tuner, location of parts, bottom view.

k. To aline band 1, proceed, as follows:

(1) Set the COARSE tuning control to the high-frequency end and measure its frequency with the signal generator and the frequency meter standard. Note this frequency as f_n.

(2) Repeat at the low-frequency extreme to find f_l.

(3) Calculate $\frac{f_n}{f_l}$. If this figure is less than 2.17, the shunt capacitance is excessive and the trimmer capacitance must be decreased; if it is greater than 2.17, there is not enough shunt capacitance in the circuit and the trimmer capacitance must be increased in value. Adjust C207B (fig. 27) in the proper direction and determine the new f_n and f_l. Repeat the process until $\frac{f_n}{f_l}$ is equal to 2.17. The trimmer is now set correctly.

(4) Next, set the FINE tuning control to 425 kc and the COARSE tuning control to position the harmonic window hairline in the middle of block No. 50. Set the signal generator to 21.25 mc and turn the FUNCTION SWITCH to COARSE. Now adjust the slug in L204 (fig. 38) to peak the rf tuner to this frequency.

(5) If the procedure has been carried out carefully, the rf tuner is now correctly alined on band 1.

l. For band 2, C207D (fig. 27) should be adjusted to give a f_n/f_l value of 2.164. Then with the FINE tuning control set to 425 kc, adjust the COARSE tuning control to cause the hairline to fall in the center of block No. 108. Next, set the signal generator to 45.9 mc and peak the FR–5/U rf tuner by adjusting the tuning slug in L209 (fig. 38).

m. For band 3, the required ratio of f_n/f_l is 2.16 which should be obtained by adjusting C207 (fig. 38) and C207H (fig. 27).

(1) When this ratio has been achieved, set the FINE tuning control to 425 kc and the COARSE tuning control to put the hairline in the center of harmonic No. 232.

(2) Next, set the signal generator to 98.6 mc

and adjust L214 to peak the rf tuner to this frequency.

Caution: Because L214 is a self-supported copper-tubing coil, it is necessary to unsolder one end and compress or spread the winding until the required value of inductance has been attained. This procedure must be carried out carefully to avoid putting a stress on the stator sections of the tuning capacitor.

(3) Each time an adjustment is made, the cover must be replaced and the result observed. When the tuned circuit is peaked to 98.6 mc, band 3 is realined correctly.

Section IV. FINAL TESTING

70. General

This section is a guide to be used in determining the quality of a repaired Frequency Meter FR-5/U. The minimum test requirements outlined in paragraphs 71 through 75 may be performed by maintenance personnel with adequate test equipment and the necessary skills. Repaired equipment meeting these requirements will furnish uniformly satisfactory operation.

71. Test Equipment Required for Final Testing

The same equipments used for calibration and alinement are suitable for final testing. Refer to paragraph 65.

72. Tests

Perform the following tests at three equally spaced frequencies in the low, center, and high regions of each of the three bands of the RANGE switch (nine times in all). If spurious responses are noted during the performance of these tests, check each such response according to paragraph 73. Perform the tests in the order given for each frequency selected, rather than performing a particular test at all frequencies, the next test at all frequencies, and so on.

a. Accuracy. Connect the rf cable from the RF INPUT jack to the frequency standard. Frequency Meter FR-5/U should measure any selected frequency to within .001 per cent.

b. Sensitivity, Audio Output and Signal-to-Noise Ratio. To perform these checks, proceed as follows:

(1) Set the FUNCTION SWITCH to COARSE, and the COARSE tuning dial in the center of block No. 24. Turn the LEVEL control fully clockwise. Connect the headphones to the PHONE jack.

(2) Connect the signal generator to the RF INPUT jack and adjust the output attenuator to a 10 mv unmodulated output. Tune the signal generator near 10 mc until a tone is heard in the headphones, or until the tuning meter indicates upscale. Connect the multimeter to the PHONES jack and adjust the COARSE tuning control for maximum audio output.

(3) Adjust the signal generator attenuator to provide 1 milliwatt (mw) (0 dbm) output. Record the input voltage reading as coarse sensitivity. It must be 10 mv or less. Reduce the signal generator output to zero. If the audio output drops at least 1 db below 1 mw, the signal-to-noise ratio is normal.

(4) Set the FUNCTION SWITCH to FINE, turn the signal generator attenuator to produce a 10 mv output and tune for zero beat. Detune slightly for maximum indication on the multimeter.

(5) Adjust the signal generator output to provide 1 mw (0 dbm) audio output. Record the input voltage reading as the fine sensitivity. It must be 10 mv or less. Reduce the signal generator output to zero. If the audio output drops at least 1 db below 1 mw, the signal-to-noise ratio is normal.

(6) Satisfactory results from the tests described above will indicate that the audio output and the signal-to-noise ratio are within desirable limits.

73. Spurious Responses

A signal generator whose frequency is to be measured is connected to the RF INPUT jack. Connect a 600-ohm nonreactive load to the PHONE jack. When a spurious response is obtained, tune the FR-5/U to produce maximum output with the input from the signal generator set to .1 volt. Measure the voltage across the load with a multimeter.

Disconnect the load, reconnect the headphones, and tune the signal to be measured to zero beat. Now disconnect the headphones, reconnect the load, and again measure the voltage across it. The previous measurement of the spurious response should be 60 db down from the measurement of the desired signal.

74. Checking Divider Networks.

a. Set the frequency of a signal generator to 1.2 mc and connect the generator and a multimeter across terminals 4 and 5 of Z502 (fig. 37). Vary the frequency of the generator a few kc above and below 1.2 mc; maximum reading on the meter should be at 1.2 mc.

b. Set the frequency of the signal generator to 2.4 mc and connect it and the multimeter across terminals 3 and 4 of Z502. Vary the frequency a few kc above and below 2.4 mc; maximum reading on the meter should be at 2.4 mc.

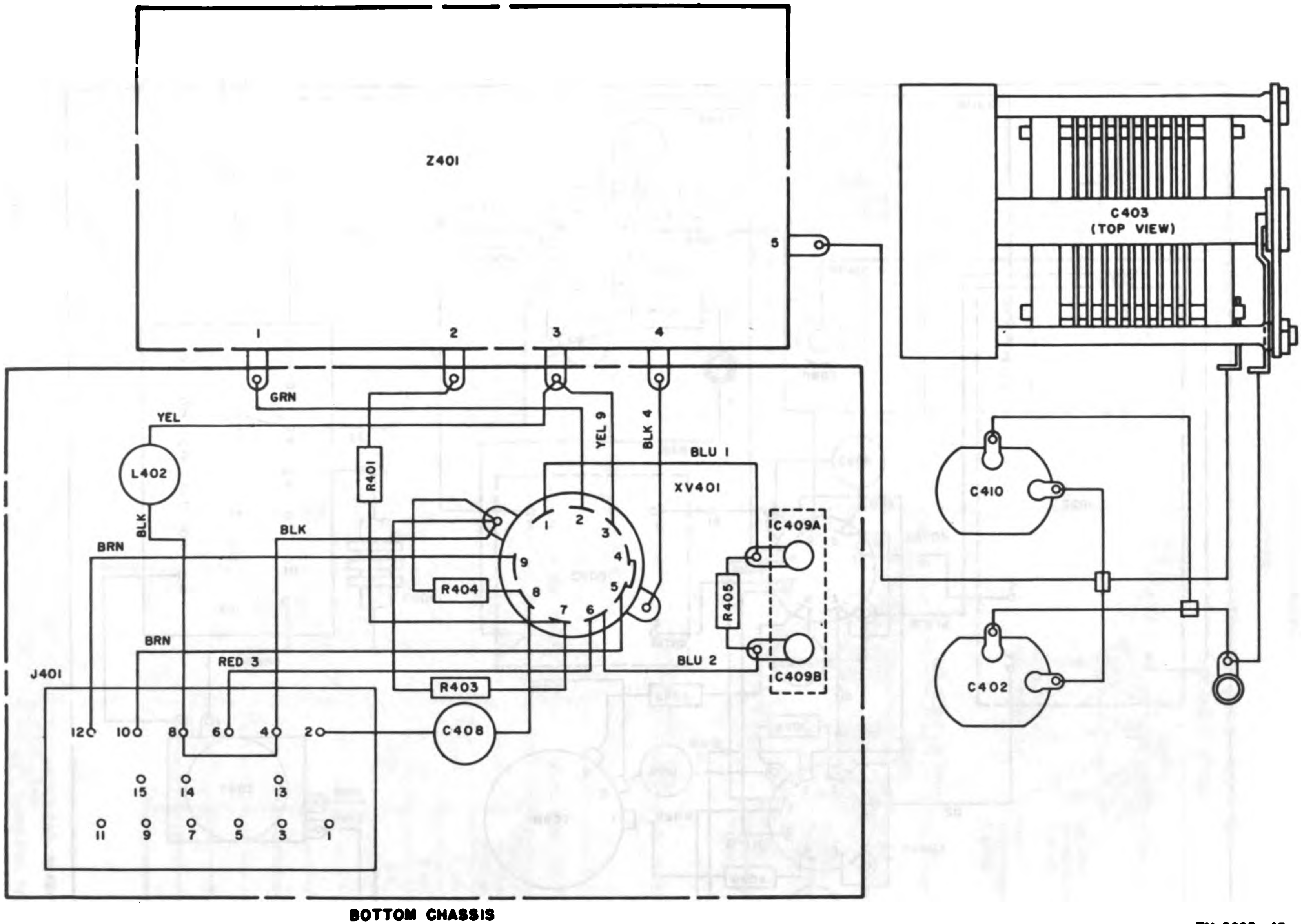
c. Set the frequency of the signal generator to 400 kc and connect it and the multimeter across terminals 4 and 5 of Z503 (fig. 37). Vary the frequency a few kc above and below 400 kc; maximum reading on the meter should be at 400 kc.

d. Set the signal generator frequency to 800 kc and connect it and the multimeter across terminals 3 and 4 of Z503. Vary the frequency a few kc above and below 800 kc; maximum reading on the meter should be at 800 kc.

e. If any of the above networks does not resonate at the designated frequency, replace the network.

75. Checking Pass Band of Audio Amplifier

Connect the output of the calibrator set between the control grid (pin 1) of V106 (fig. 31) and the chassis. Connect a multimeter between the plate (pin 7) of V107 and the chassis. Observe the meter readings over the range of 200 to 1,100 cycles. If the above frequency range is not passed, perform resistance and voltage measurements. Replace faulty components.



TM 5095-43

Figure 44. Frequency Meter FR–5/U, interpolation oscillator, wiring diagram.

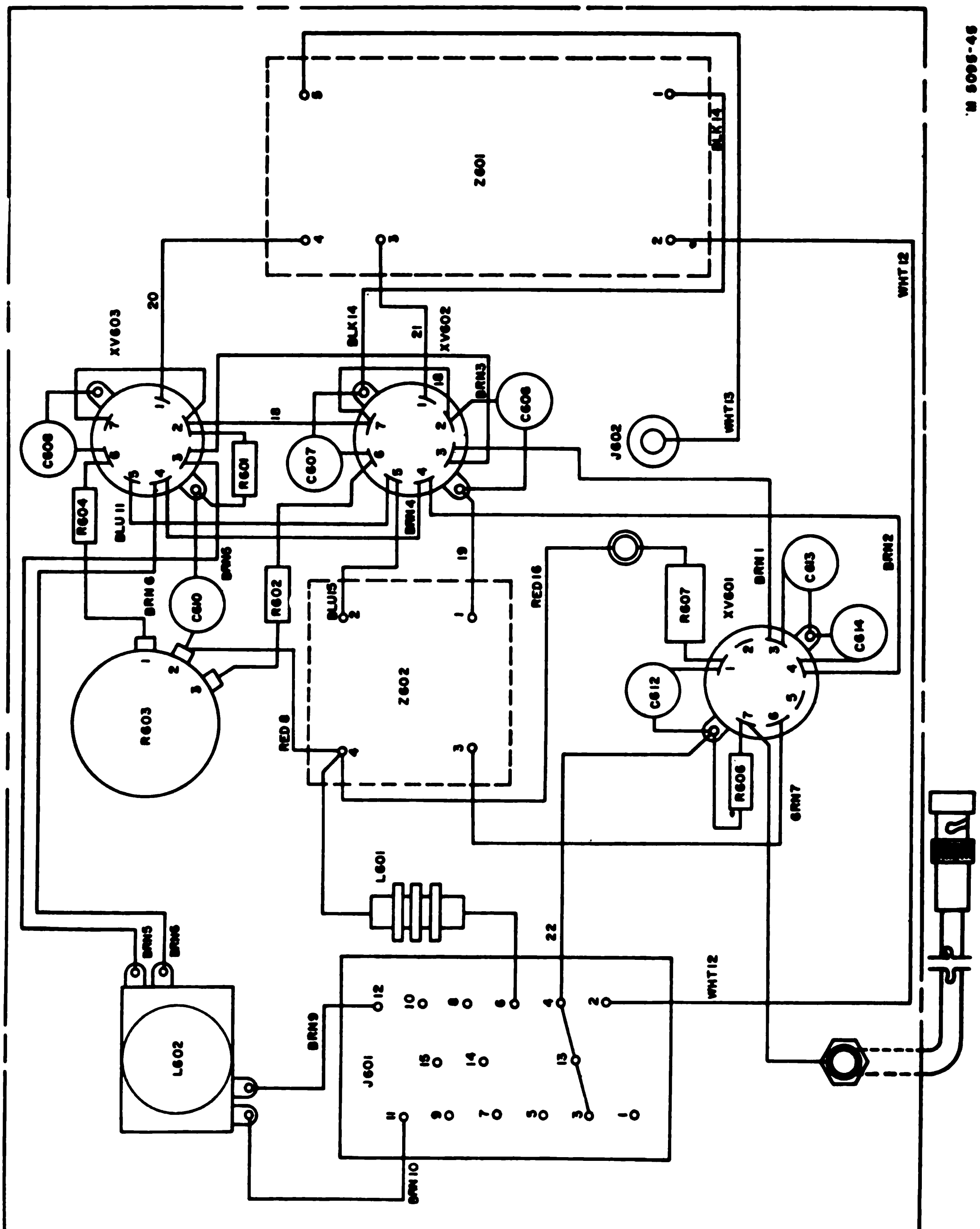
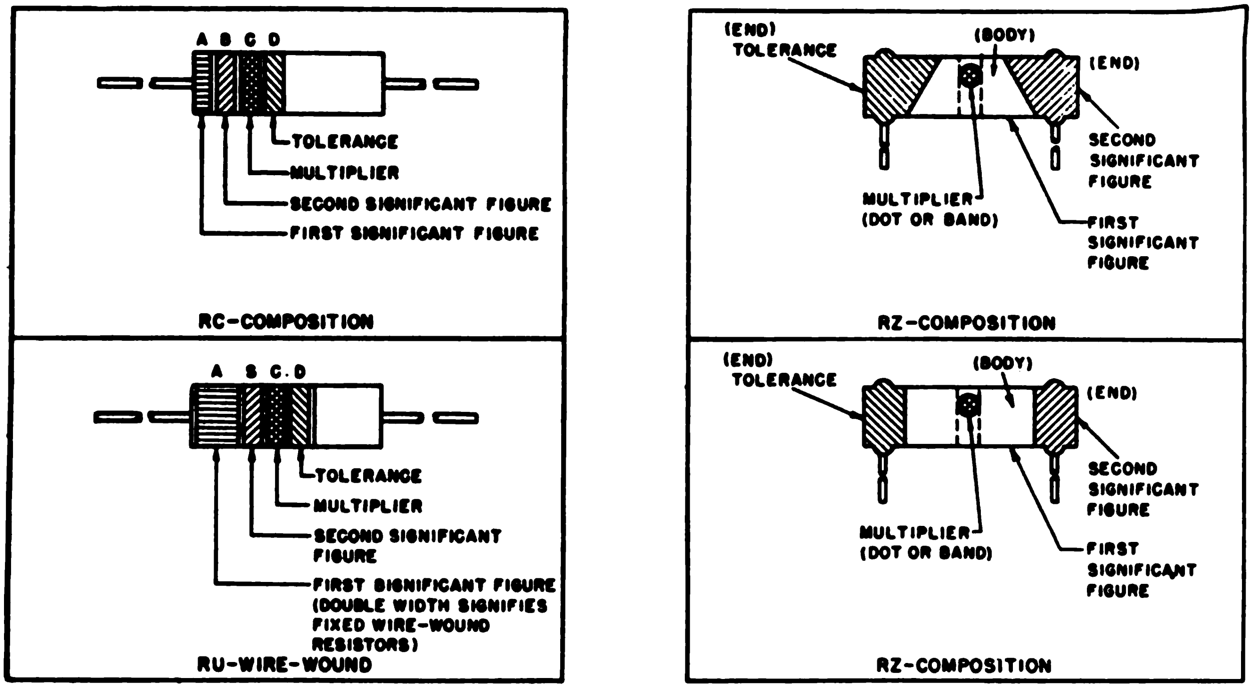


Figure 46. Frequency Meter FR-6/U, balanced modulator, wiring diagram.

RESISTOR COLOR CODE MARKING
(MIL-STD RESISTORS)

AXIAL-LEAD RESISTORS (INSULATED) — RADIAL-LEAD RESISTORS (UNINSULATED)



RESISTOR COLOR CODE

BAND A OR BODY*		BAND B OR END*		BAND C OR DOT OR BAND*		BAND D OR END*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1	BODY	± 20
BROWN	1	BROWN	1	BROWN	10	SILVER	± 10
RED	2	RED	2	RED	100	GOLD	± 5
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000		
GREEN	5	GREEN	5	GREEN	100,000		
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	GOLD	0.1		
WHITE	9	WHITE	9	SILVER	0.01		

*FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH. WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND) OR END COLOR, THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

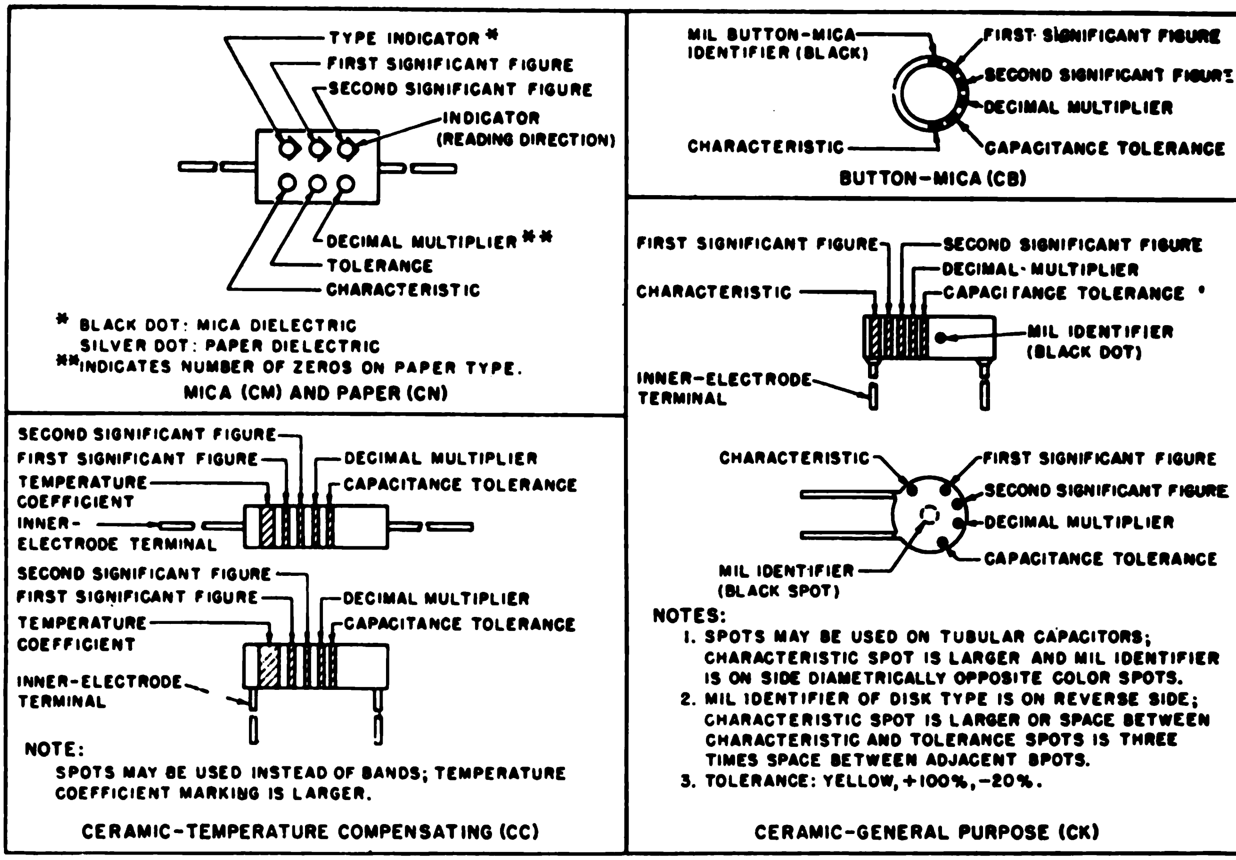
EXAMPLES (BAND MARKING):
10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B; BLACK BAND C; NO BAND D.
4.7 OHMS ±5 PERCENT: YELLOW BAND A; PURPLE BAND B; GOLD BAND C; GOLD BAND D.

EXAMPLES (BODY MARKING):
10 OHMS ±20 PERCENT: BROWN BODY; BLACK END; BLACK DOT OR BAND; BODY COLOR ON TOLERANCE END.
3,000 OHMS ±10 PERCENT: ORANGE BODY; BLACK END; RED DOT OR BAND; SILVER END.

STD-R1

Figure 47. Resistor color codes.

CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)



CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER: DECIMAL	MULTIPLIER: NUMBER OF ZEROS	CHARACTERISTIC[1]: CM	CHARACTERISTIC[1]: CN	CHARACTERISTIC[1]: CB	CHARACTERISTIC[1]: CK	TOLERANCE[2]: CM	TOLERANCE[2]: CN	TOLERANCE[2]: CB	TOLERANCE[2]: CC OVER 10UUF	TOLERANCE[2]: CC 10UUF OR LESS	TEMPERATURE COEFFICIENT (UUF/UF/°C): CC
BLACK	0	1	NONE		A			20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W				1		−30
RED	2	100	2	C	H		X	2		2	2		−80
ORANGE	3	1,000	3	D	J	D			30				−150
YELLOW	4	10,000	4	E	P								−220
GREEN	5		5	F	R						5	0.5	−330
BLUE	6		6		S								−470
PURPLE (VIOLET)	7		7		T	W							−750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	−330(±500)[3]
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

1. LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2. IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION

STD-C1

Figure 48. Capacitor color codes.

CHAPTER 7

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

76. Disassembly

The following instructions are recommended as a general guide for preparing Frequency Meter AN/URM-80 for transportation and storage.

a. Wrap Cord CG-409/U in waterproof barrier material and place it inside Meter Case CY-1501/U.

b. Slide Frequency Meter FR-5/U into the case and tighten the eight wing nuts, four on each side, to secure the frequency meter in place.

c. Replace the meter case front cover. Secure the cover with the eight clamps, two on each side.

77. Repacking for Shipment or Limited Storage

a. Materials Required. The following chart lists the estimated amount of materials required to prepare Frequency Meter AN/URM-80 for shipment:

Materials	Amount
Waterproof barrier	17 sq ft
Single face, corrugated paper	20 sq ft
Flat steel strapping	9 ft
Wooden shipping box	1 ea
Pressure-sensitive type	25 ft

b. Box Size. The dimensions of the shipping box required for the frequency meter are given below.

Box No.	Inner dimensions			Board ft	Volume (cu ft)	Packed weight (lb)
	Height (in.)	Width (in.)	Depth (in.)			
1 of 1	19	25	24	26	8.4	140

c. Construction of Wooden Shipping Box. The wooden shipping box must be big enough to allow a 1-inch clearance on all sides between the packaged frequency meter and the box. Using figure 3 as a guide, construct the box as follows:

(1) Construct the bottom of the box. To determine the dimensions of the bottom, add twice the thickness of the material used to the dimensions given in *b* above.

(2) Construct the two long sides; add twice the thickness of the material used to the dimensions given in *b* above.

(3) Construct the two short sides; add twice the thickness of the material used to the dimensions given in *b* above. Add the two vertical and two horizontal reinforcing members to each short side as shown.

(4) Construct the top of the box; add twice the thickness of the material used to both dimensions.

(5) With the exception of the top, assemble the box and nail it together.

d. Moistureproofing. Wrap Frequency Meter AN/URM-80 completely in the waterproof barrier; using the pressure-sensitive tape to seal up all joints.

e. Packing and Strapping.

(1) Using a piece of corrugated paper twice the length of the box, fold it in half so that it forms a cushion at the bottom of the box.

(2) Place the meter in the box; pack corrugated paper around all sides to prevent any movement. As in (1) above, place a layer of folded corrugated paper on top of the meter to cushion the top. If necessary, add additional paper under the cover.

(3) Nail the box top on securely.

(4) Strap the box for intertheater shipment only. The strapping should run at right angles to the grain of the wood as shown in figure 3.

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

78. General

The demolition procedures outlined in paragraph 79 will be used to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished only upon the order of the commander.

79. Methods of Destruction

a. Smash. Smash the controls, tubes, coils, switches, capacitors, transformers, and meter; use sledges, axes, handaxes, pickaxes, hammers, crowbars, or heavy tools.

b. Cut. Cut the output and power cord and slash the rf shield; use axes, handaxes, or machetes.

c. Burn. Burn cords and manuals; use gasoline, kerosene, oilflame throwers, or incendiary grenades.

d. Bend. Bend panel and cabinet.

e. Explosives. If explosives are necessary, use firearms, grenades, or TNT.

f. Disposal. Bury or scatter the destroyed parts in slit trenches, fox holes, or throw them into streams.

g. Destroy. Destroy everything.

INDEX

[AG 412.44 (5 Jul 55)]

BY ORDER OF THE SECRETARY OF THE ARMY:

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General, United States Army,
Chief of Staff.

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  11-57R, Armd Sig Co (2)
  11-127R, Sig Rep Co (2)
  11-128R, Sig Depot Co (2)
  11-500R, (AA-AE), Sig Svc Org (2)
  11-557R, Abn Sig Co (2)
  11-587R, Sig Base Maint Co (2)
  11-592R, Hq & Hq Co, Sig Base Depot (2)
  11-597R, Sig Base Depot Co (2)

NG: State AG (6); Units—same as Active Army except allowance is one copy to each unit.

USAR: None.

Unless otherwise noted, distribution applies to CONUS and overseas.

For explanation of abbreviations used, see SR 320-50-1.

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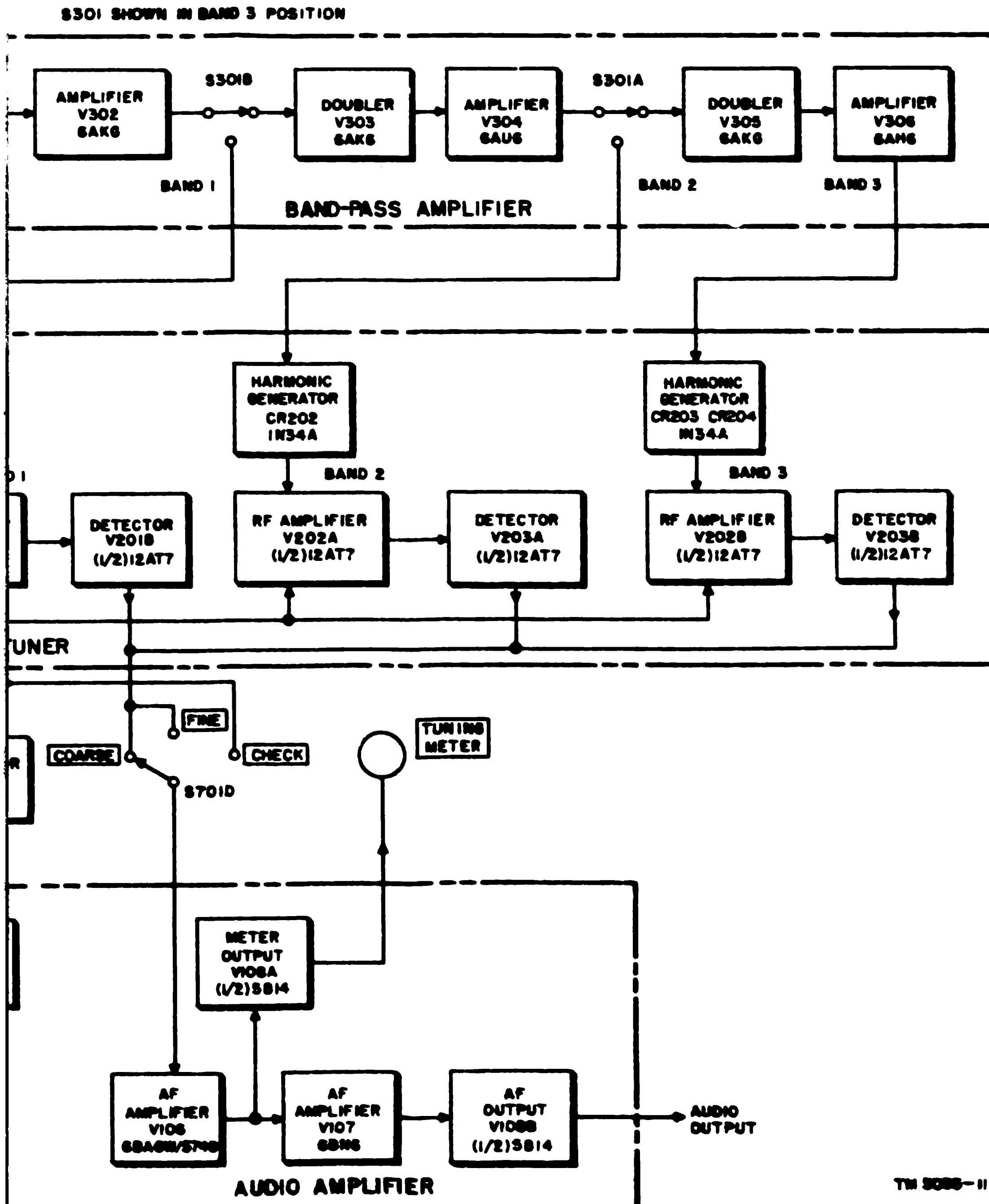
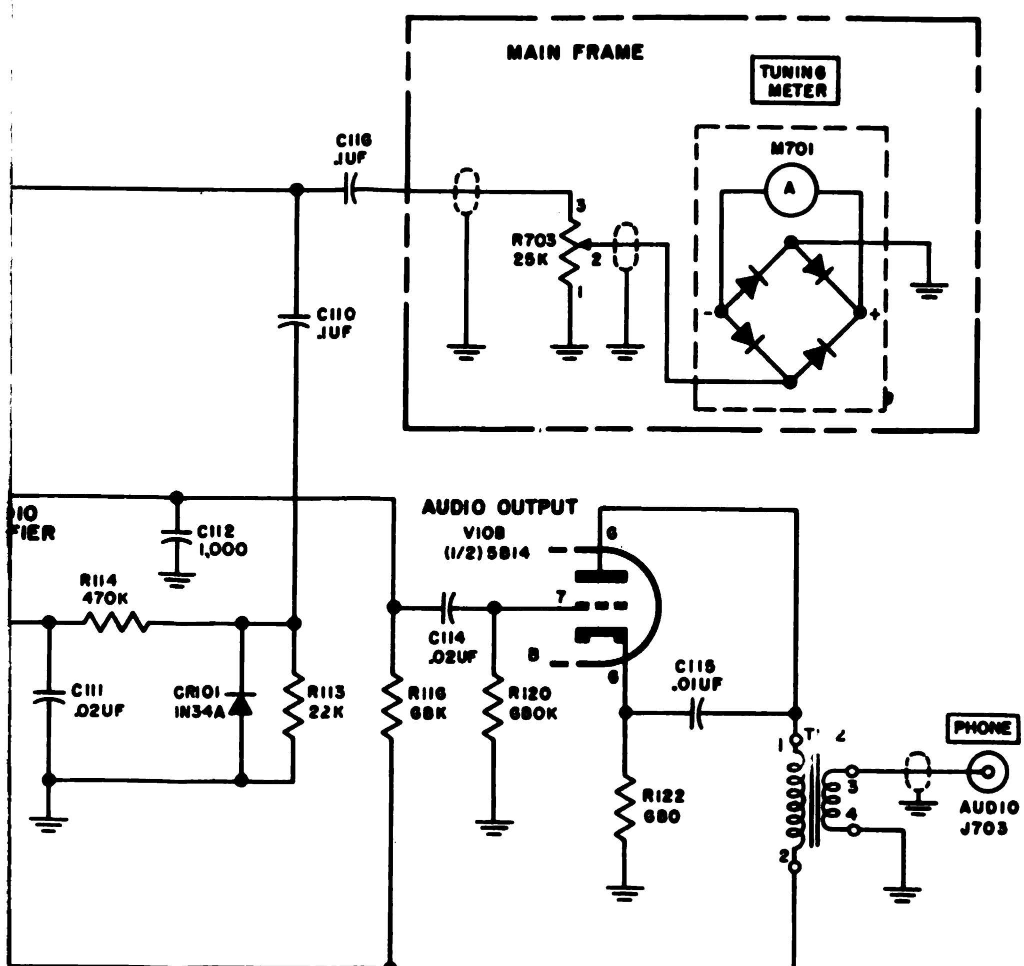


R-5/U, block diagram.



ified schematic diagram.

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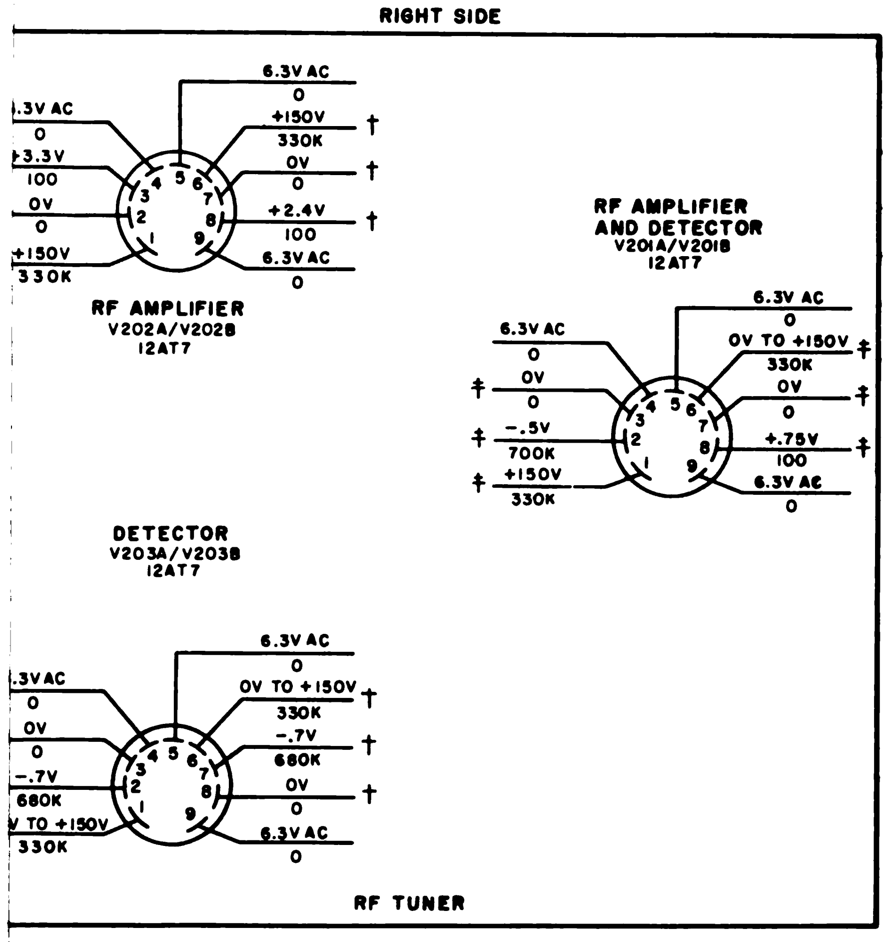
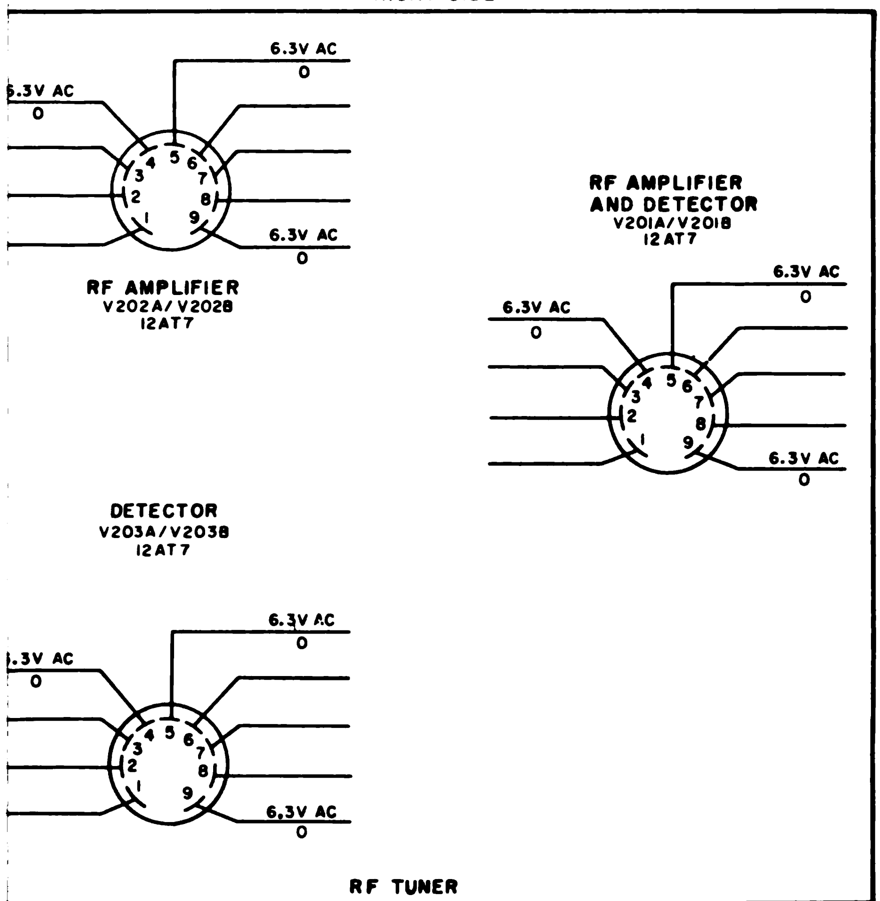


ES:
INE VOLTAGE 110V OR 220V WITH 110/220 VOLT SWITCH IN CORRESPONDING POSITION.
LTAGE READINGS ABOVE LINE, RESISTANCE READINGS BELOW LINE.
C INDICATES NO CONNECTION.
DENOTES $\boxed{\text{RANGE}}$ SWITCH IN $\boxed{\text{10-21.7MC}}$ POSITION;
DENOTES $\boxed{\text{RANGE}}$ SWITCH IN $\boxed{\text{21.7-46.7MC}}$ POSITION;
DENOTES $\boxed{\text{RANGE}}$ SWITCH IN $\boxed{\text{46.7-100MC}}$ POSITION.
$\boxed{\text{EVEL}}$ CONTROL IN MAXIMUM CLOCKWISE DIRECTION.

RIGHT SIDE



S:

NE VOLTAGE 110V OR 220V WITH 110/220 VOLT SWITCH IN CORRESPONDING POSITION.

OLTAGE READINGS ABOVE LINE, RESISTANCE READINGS BELOW LINE.

C INDICATES NO CONNECTION.

VEL CONTROL IN MAXIMUM CLOCKWISE DIRECTION.

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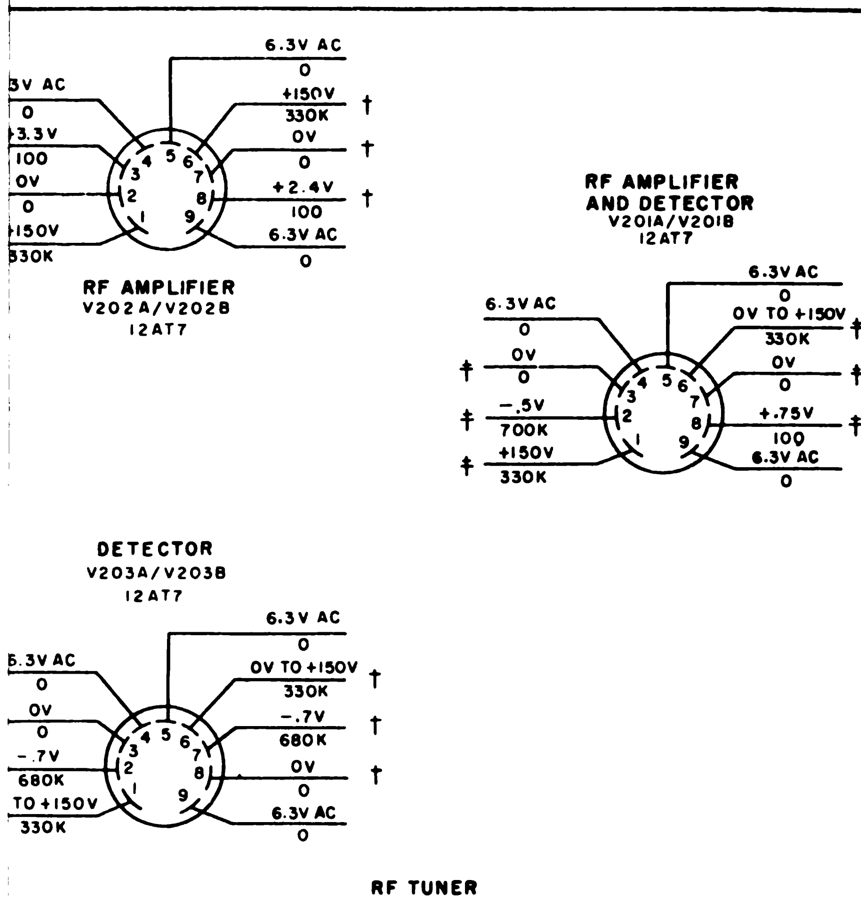
RIGHT SIDE



S:

ɪE VOLTAGE 110V OR 220V WITH 110/220 VOLT SWITCH IN CORRESPONDING POSITION.

LTAGE READINGS ABOVE LINE, RESISTANCE READINGS BELOW LINE.

INDICATES NO CONNECTION.

DENOTES RANGE SWITCH IN 10-21.7 MC POSITION;

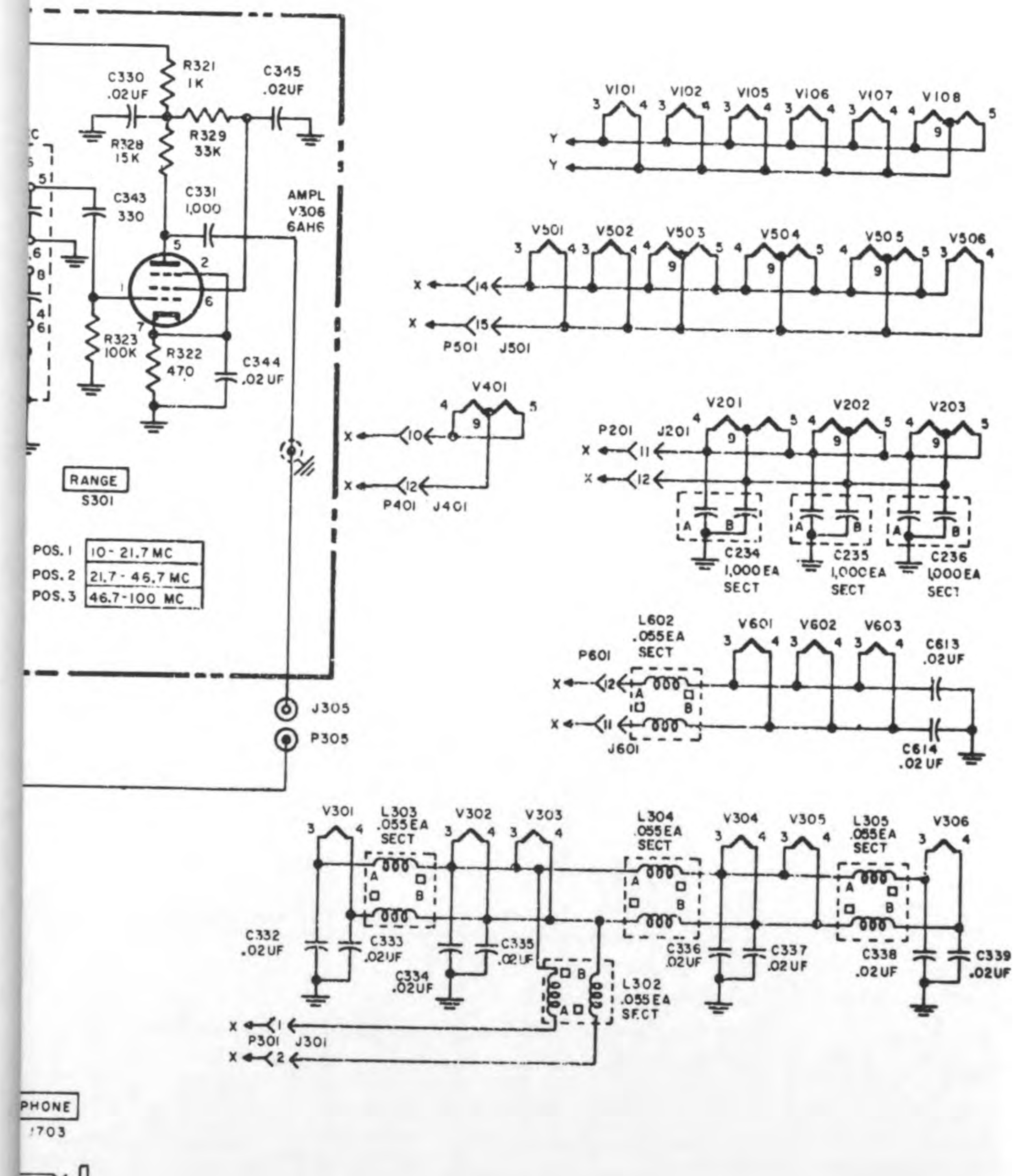
DENOTES RANGE SWITCH IN 21.7-46.7 MC POSITION;

DENOTES RANGE SWITCH IN 46.7-100 MC POSITION.

VEL CONTROL IN MAXIMUM CLOCKWISE DIRECTION.

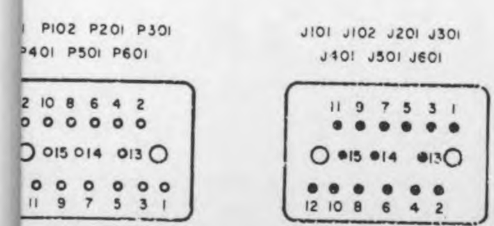
BANDPASS AMPLIFIER 1, 2, 3 INDICATES OPERATING BAND.

TM 5095-46



NOTE

1. UNLESS OTHERWISE SPECIFIED, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF, INDUCTANCES ARE IN MILLIHENRIES
2. ROTARY SWITCHES ARE VIEWED FROM REAR AND ARE SHOWN IN POSITION 1
3. C207, LOCATED IN R F TUNER, 14-88 UF EACH, WITH TRIMMERS B, D, F, H



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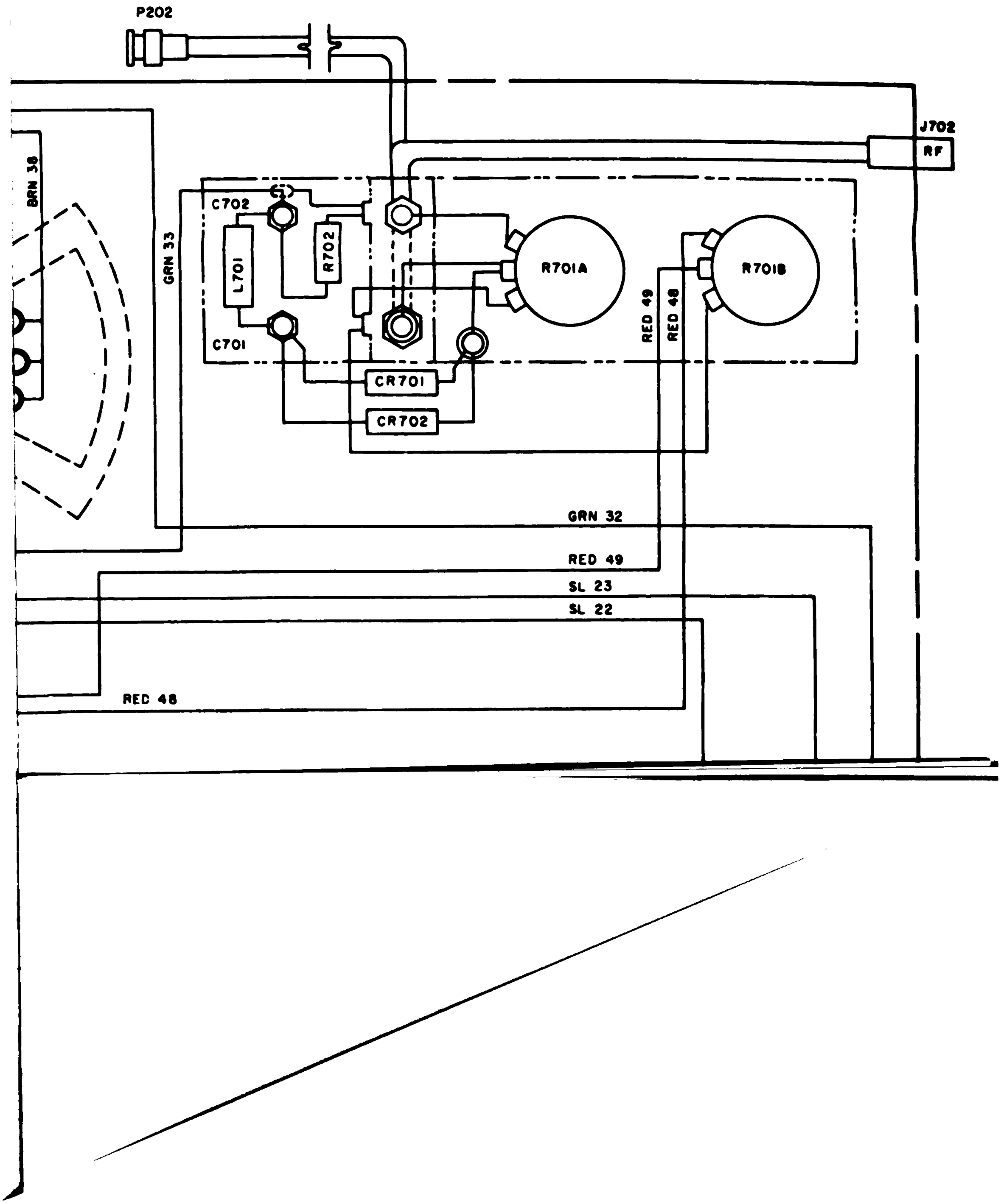
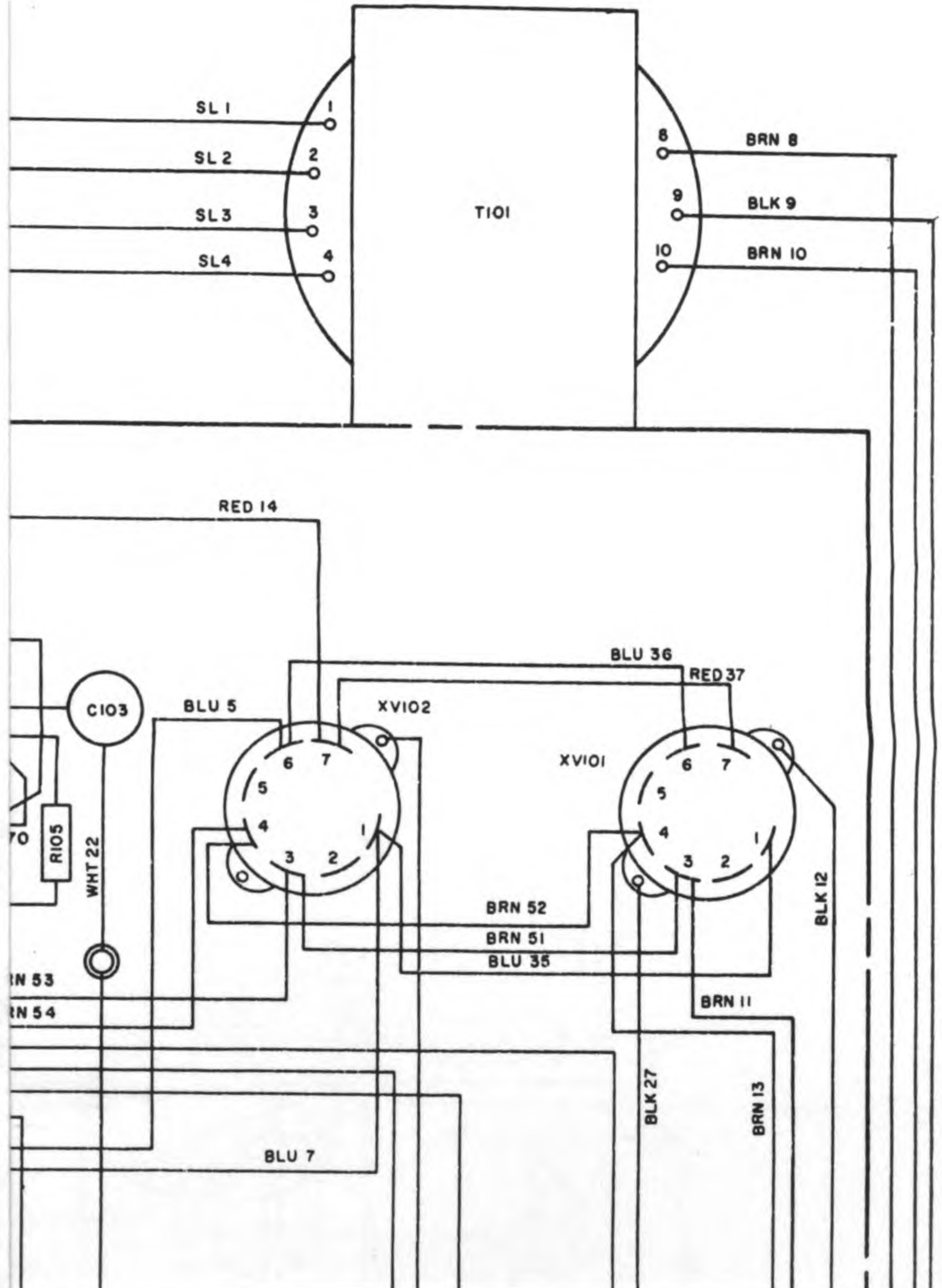
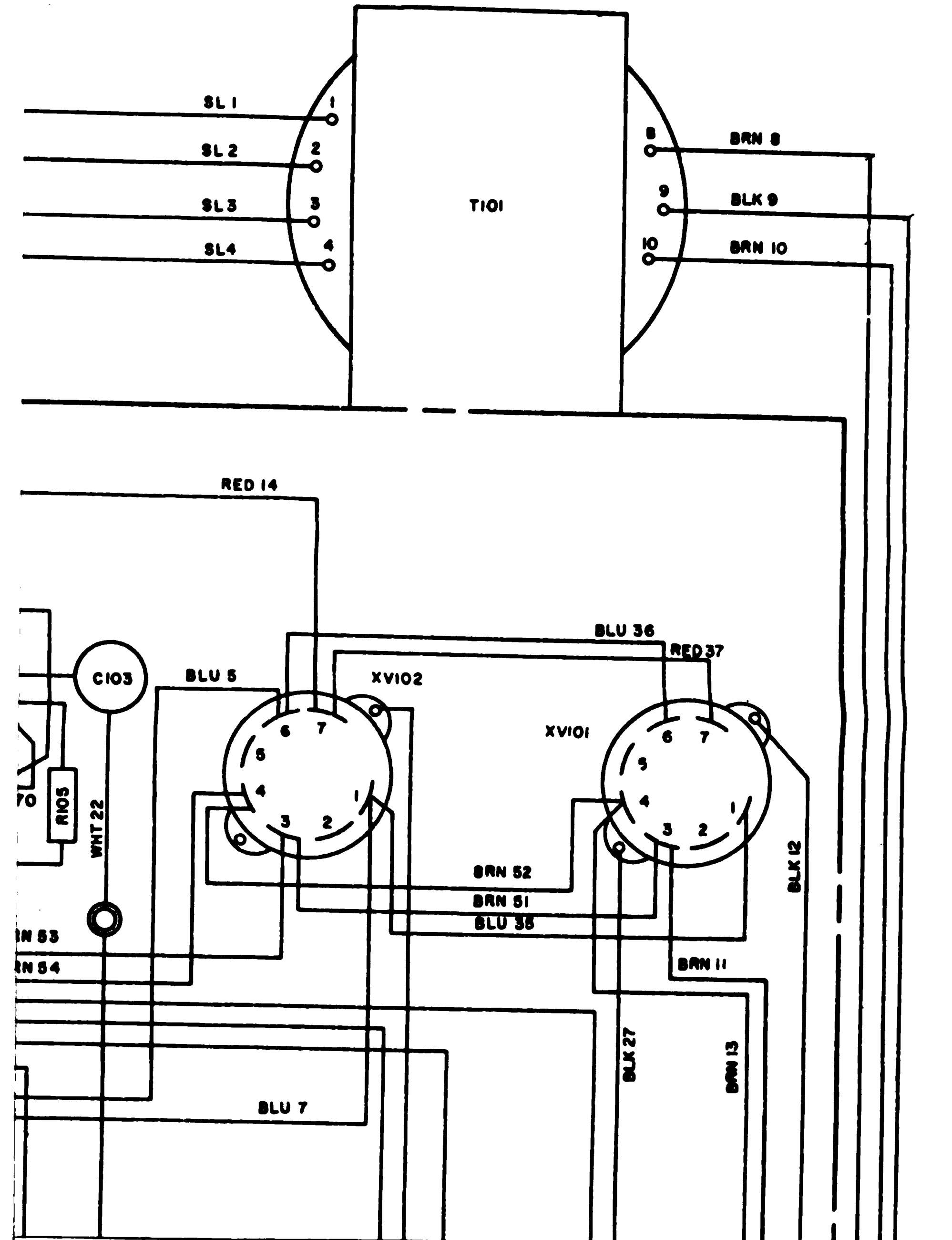
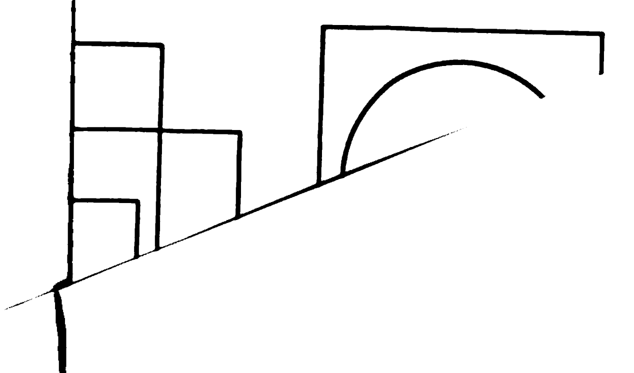

P202
J702
RF
BRN 38
GRN 33
C702
L701
R702
C701
R701A
R701B
RED 49
RED 48
CR701
CR702
GRN 32
RED 49
SL 23
SL 22
RED 48



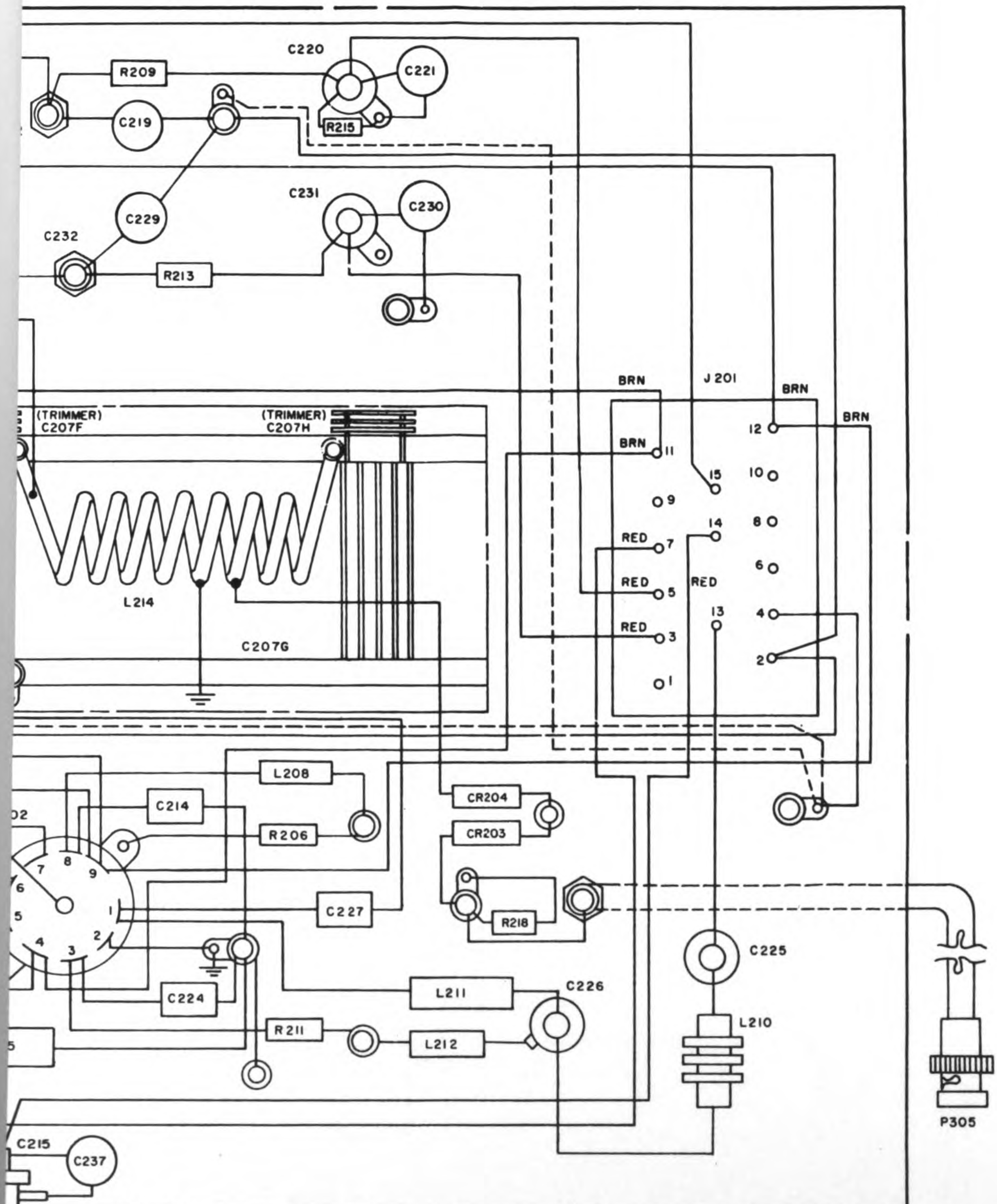
supply, wiring diagram.



supply, wiring diagram.



rf tuner,



rf tuner, wiring diagram.

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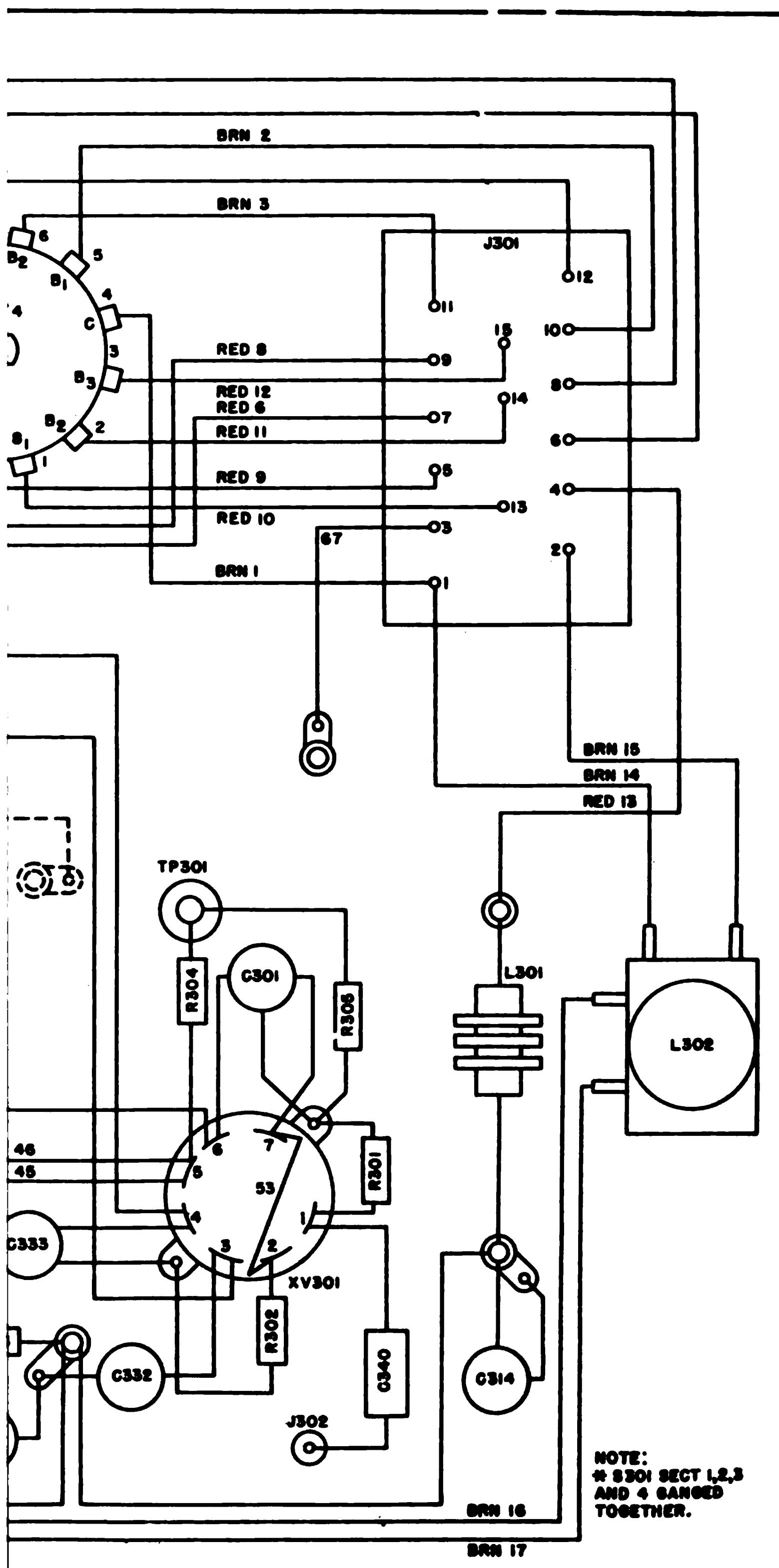

NOTE:
S301 SECT 1,2,3
AND 4 GANGED
TOGETHER.

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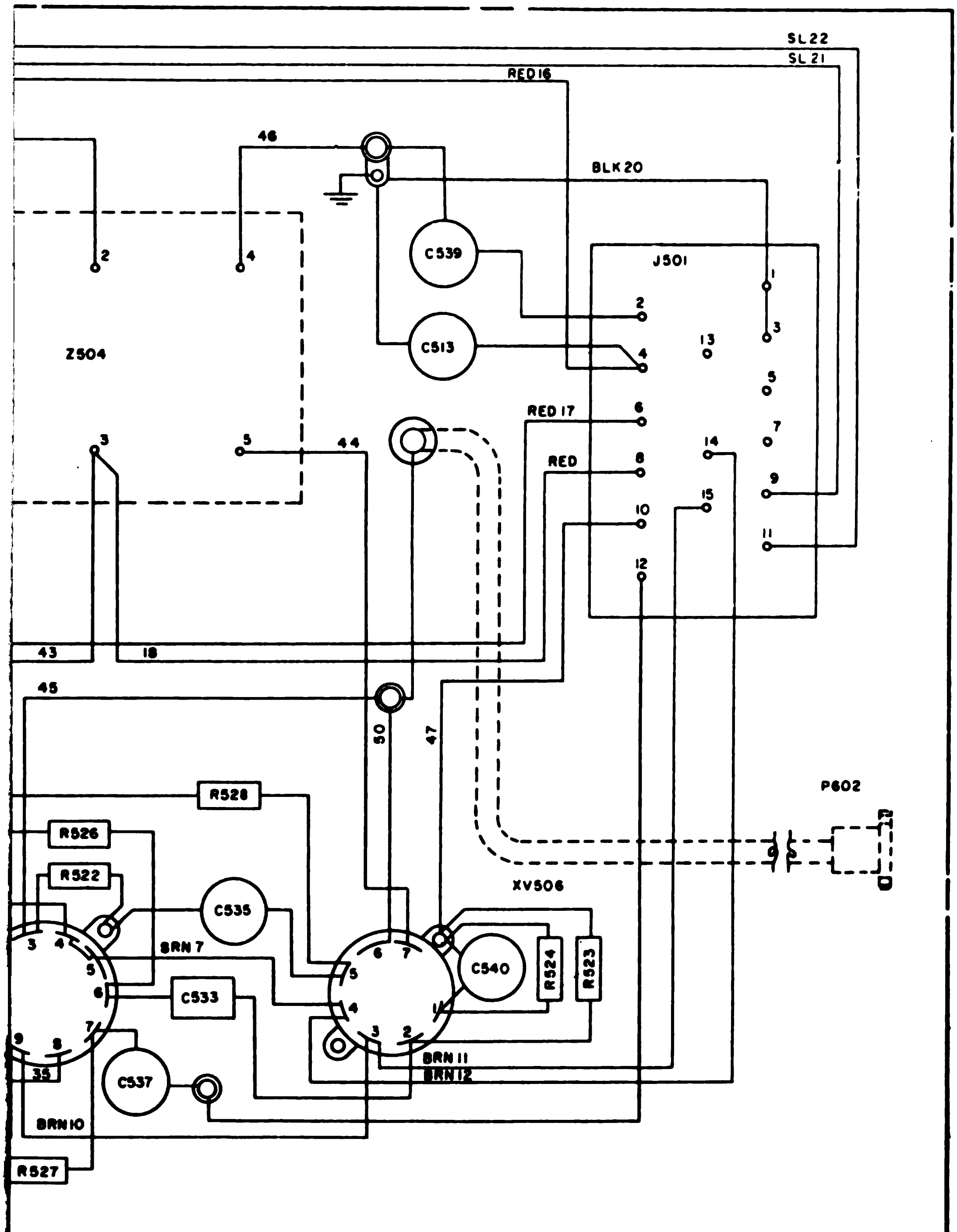
SL22
SL21
RED16
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BLK20
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R528
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XV506
BRN 7
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R523
C533
C537
BRN 11
BRN 12
BRN10
R527

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