

MAINTENANCE

SECTION 5

MAINTENANCE

5.1. INSPECTION.

5.1.1. GENERAL. - This radio equipment has been constructed of materials considered to be the best obtainable for the purpose, and has been carefully inspected and adjusted at the factory to reduce maintenance to a minimum. However, a certain amount of checking and servicing will be necessary to maintain efficient and dependable operation. The following section has been written to aid in checking the equipment.

5.1.2. ROUTINE INSPECTION. - Routine inspection schedules should be set up for periodic checks of this equipment. This inspection should include examination of the mechanical system for excessive wear or binding, and of the electrical system for electrical defects and deterioration of components.

If routine inspection of the equipment is carried out faithfully, the chances of improper operation of the equipment are greatly minimized. It is important, therefore, that this inspection be made as frequently as possible, and should be sufficiently thorough to include all major electrical circuits of the equipment as well as the mechanical portion.

5.1.3. CLEANING. - The worst enemies of uninterrupted service in equipment of this type are dirt and corrosion. Dirt reduces efficiency and causes undue wear of rotating parts, Corrosion most seriously affects contacts such as those on tap switches, tubes, relays and cables. Like salt laden air, dirt and moisture accelerate corrosion. The result may be equipment failure for no apparent reason.

Periodic dusting of accessible parts by means of a soft brush and a jet of dry, oil-free air removes foreign particles. Under certain conditions it is difficult or virtually impossible to prevent accumulation of moisture. Even so, frequent wiping of parts lessens danger of corrosion. If the atmosphere is corrosive, frequent inspection and wiping of parts is of especial importance.

5.1.4. VACUUM TUBES. - Check the emission characteristics of all tubes; then examine all tube prongs to make sure they are free from corrosion. Straighten bent pins with a tube pin straightener. See that all tubes are firmly seated in their proper sockets, and that a good electrical contact exists between tube prong and socket. Before discarding a tube, be sure that it is at fault and that the trouble is not due to a loose or broken connection within the equipment. Keep an extra set of tested tubes on hand at all times. If an equipment's faulty performance seems due to tube failure, check the tubes by replacing them with the extras. Inspection will usually locate

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defective tubes that are overloading power circuits. Excessive heating or sputtering within a vacuum tube indicates a fault in the tube circuit.

5.1.5. TUBE REPLACEMENT PRECAUTIONS.

(a) Remove tubes by pulling them straight up.

(b) Before inserting a tube, make certain that the pins are straight and that it is of the correct type for the socket into which it is to be placed.

5.1.6. TUBE TABLE .

RECEIVER:

<u>Symbol</u>	<u>Type</u>	<u>Function</u>
V101	6AK5	RF amplifier
V102	6BE6	First mixer
V103	6BE6	Band 1 mixer
V104	6BA6	Calibration oscillator
V105	6AK5	Crystal h-f oscillator
V106	6BE6	Second mixer
V107	6BA6	First 500 kc i-f amplifier
V108	6BA6	Second 500 kc i-f amplifier
V109	6BA6	Third 500 kc i-f amplifier
V110	12AX7	Detector and AVC rectifier
V111	12AU7	AVC amplifier and i-f output cathode follower
V112	12AX7	Noise limiter and first audio amplifier
V113	6AQ5	Audio power amplifier
V114	6BA6	Beat frequency oscillator
V115	5V4	Power rectifier
V116	0A2	Voltage regulator
V001	6BA6	Variable frequency oscillator
V002	6BA6	Oscillator isolation amplifier

5.2. TROUBLE SHOOTING.

5.2.1. GENERAL. - Improper performance of radio equipment is usually due to tube failure. Refer to paragraph 5.1.4. In general, the type of trouble encountered in radio apparatus can be ascertained by means of various tests and measurements. Components in the associated circuit may then be checked and the cause of trouble located.

Useful resistance and voltage measurements will be found in table 5-1.

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NOTE

NO ONE BUT AN AUTHORIZED AND COMPETENT SERVICE MAN EQUIPPED WITH PROPER TEST FACILITIES SHOULD BE PERMITTED TO SERVICE THIS EQUIPMENT.

5.2.2. FUSES. - This equipment contains fuses of the correct rating. Replace blown fuses only after carefully examining affected circuits to make certain that no permanent fault exists. Use only 1.5 ampere, slow-blow fuses.

5.3. ALIGNMENT.

5.3.1. GENERAL. - Should the receiver get out of alignment, return it to satisfactory performance by means of the following procedure.

5.3.2. EQUIPMENT AND TOOLS USED FOR ALIGNMENT.

- (a) 500-kc to 30.5-mc signal generator.
- (b) D-c vacuum tube voltmeter.
- (c) Oscilloscope.
- (d) Detuning network consisting of a .01 capacitor and 4700-ohm resistor in series with clip leads.
- (e) Fiber or bakelite adjusting tool, 1/8-inch diameter with screwdriver type bit. (Supplied)
- (f) Fiber or bakelite adjusting tool, 5/16-inch diameter with screwdriver type bit. (Supplied)
- (g) Small screwdriver.

NOTE

IF A SIGNAL GENERATOR IS NOT AVAILABLE THE CALIBRATION OSCILLATOR MAY BE USED FOR ALIGNMENT. USE THE PROCEDURE OUTLINED BELOW BUT LEAVE THE CALIBRATION OSCILLATOR ON. TUNE RECEIVER TO EACH ALIGNMENT FREQUENCY BY TURNING THE KILOCYCLE KNOB UNTIL A PEAK READING IS OBTAINED ON THE INPUT METER, AND TUNE TRIMMERS AND CORES, USING INPUT METER TO INDICATE MAXIMUM READINGS.

5.3.3. CRYSTAL OSCILLATOR TRIMMER ADJUSTMENT.

- (a) Adjust trimmer C167, marked XTAL on chassis, to provide an input capacitance of 32 mmf across the crystal holders. This value will occur at or near minimum capacitance setting. If this capacitor is badly

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mistuned, the crystals will be off frequency and low in output.

(b) Connect a 470K-ohm resistor to pin 7 of tube V102. Connect VTVM between free end of 470K-ohm resistor and chassis. This resistor reduces the effect of the capacitance of the meter lead.

(c) In all of the following adjustment, peak the trimmers if the indicated voltage is not more than 2 volts. If it is more than 2 volts, de-tune trimmer toward minimum capacitance, until voltage reads 2. See figure 5-1.

(1) Repeat, tuning trimmer marked 30, with bandswitch on band 30.

(2) Repeat, tuning trimmer marked 28, with bandswitch on band 28.

(3) Repeat on even bands from 26 through 14, tuning correspondingly marked trimmers.

(4) Repeat with bandswitch on band 1. Adjust trimmer labeled B.C. that is nearer V105.

(d) Remove 470K-ohm resistor from V102. Connect the resistor to pin 1 of V103. Connect VTVM between free end of resistor and chassis.

(e) Place bandswitch on band 1. Tune for maximum indication on VTVM the trimmer marked B.C. that was not previously tuned.

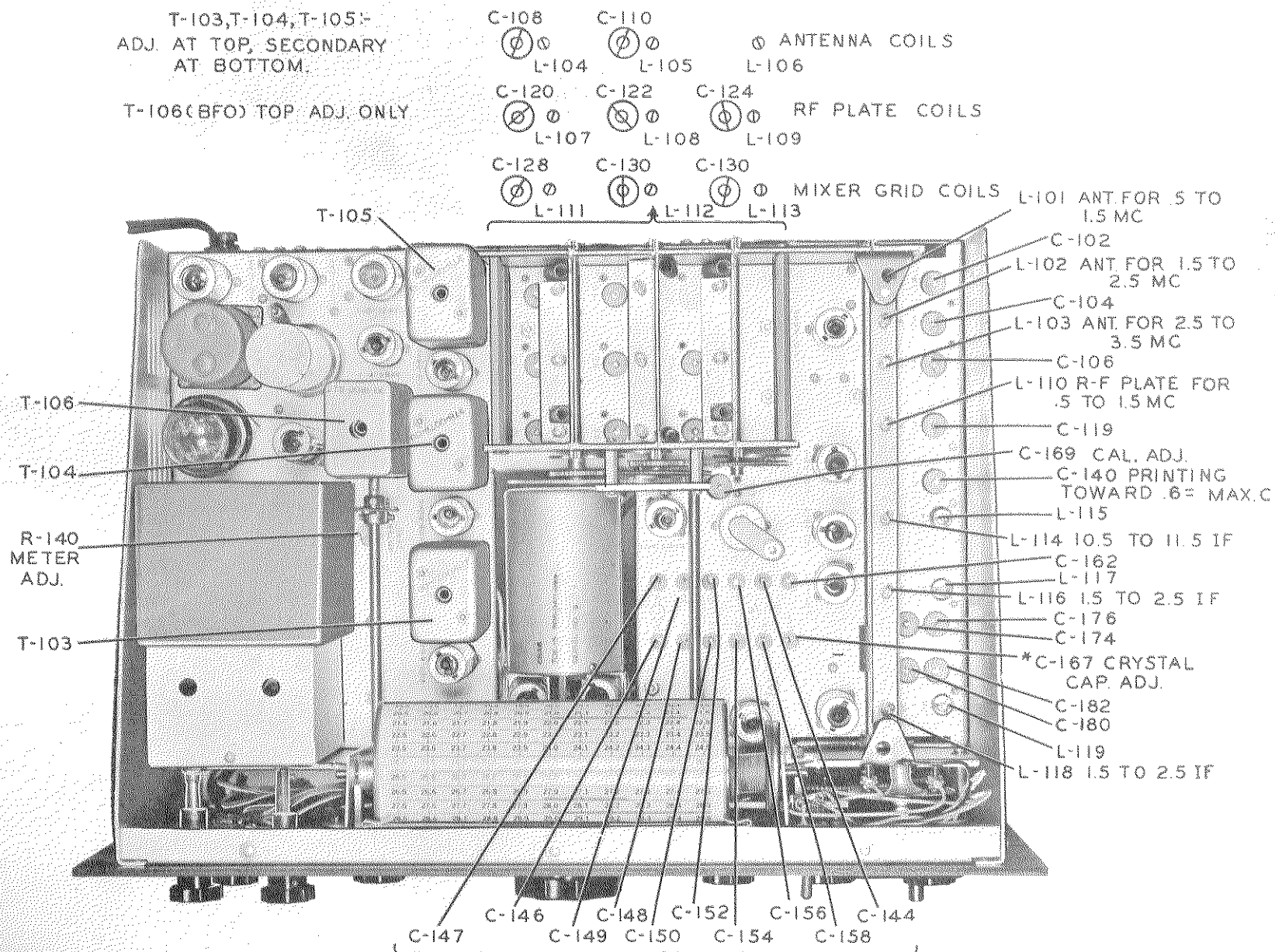
5.3.4. 100 KC OSCILLATOR ALIGNMENT. - Calibrate the 100-kc crystal oscillator by means of the CAL trimmer, C169, using a secondary frequency standard. D-c grid voltage on V104 as measured with the d-c VTVM is a negative 15-30 volts minimum.

5.3.5. FIXED 500 KC I-F AMPLIFIER ALIGNMENT. - Connect signal generator between pin 7 of V106 and chassis. Connect one end of a clip lead to output of crystal oscillator at C173. Hold other end near grid of V106. Set signal generator to zero beat at 500 kc. Turn off 100-kc oscillator and remove clip lead. Connect detuning network consisting of an .01-mf capacitor in series with a 4700-ohm resistor from plate of V107 to chassis. Connect VTVM from diode load resistor R151 to chassis. Place S114 in "0" position.

(a) Tune secondary of T103 by adjusting the bottom slug for maximum indication. Keep diode load voltage below 3 volts by adjusting signal generator output.

(b) Connect detuning network from terminal 4 of T103 to chassis. Tune top slug, or primary, for maximum indication.

Figure 5-1. 51f-3 Alignment Adjustments



NOTE: MINIMUM CAPACITY OCCURS WITH
CAP. PRINTING TOWARDS BAND NUMBERS

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(c) Connect detuning network from plate of V108 to chassis. Tune secondary of T104 for maximum indication.

(d) Connect detuning network to terminal 4 to T104. Tune primary of T104 for maximum indication.

(e) Connect detuning network to plate of V109. Tune secondary of T105 for maximum indication.

(f) Connect detuning network to terminal 4 of T105. Tune primary of T105 for maximum indication.

(g) Tune T101 for maximum VTVM indication.

(h) If the BFO PITCH knob has never been removed from the shaft during the life of the receiver, align the BFO as follows. Turn BFO on. Set the line on the BFO PITCH knob at the fiducial mark on the panel. Adjust core in T106 to zero beat.

If the BFO PITCH knob has ever been removed from the shaft, align the BFO as follows. Turn BFO on. Adjust core in T106 to produce a beat note. Line up the knob with the panel mark and with the mid-range point of the BFO pitch capacitor by turning the knob to either the right or the left of the fiducial panel mark until pitch of beat note rises to a maximum. Leave knob exactly at point of maximum pitch. BFO PITCH capacitor plates are now either all in or all out. Loosen set screws in BFO PITCH knob. Rotate knob on shaft until knob mark is 90° from panel mark. Tighten set screws. Set knob mark at fiducial mark on panel. BFO PITCH capacitor is now at mid-range. Adjust core of T106 to zero beat. (A method of aligning the BFO without a signal generator is given in paragraph 5.3.6. below.)

(i) Align T102 as follows:

(1) Use an oscilloscope and a frequency-modulated signal generator having a sweep rate of four cycles per second, a frequency excursion of about 20 kc and a carrier frequency between 1.5 and 3.5 mc.

(2) Line up the crystal filter PHASING control knob with the panel mark and with the mid-range position of the phasing capacitor. To accomplish this, with the aid of a flashlight look into the right-hand hole in the top of the crystal filter cover in order to see the plates of the phasing capacitor. Turn the PHASING control until the rotor plates are straight down toward the bottom of the receiver, i.e., until the rotor plates completely engage the bottom set of stator plates. Loosen set screws in PHASING control knob. Set knob line 90° to the left of the panel mark. Tighten set screws. Turn knob to panel mark. Phasing capacitor is now at mid-range.

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(3) Connect signal generator lead to pin 7 of V106. Connect oscilloscope lead to junction of R150 and R152. Turn on generator and oscilloscope and allow them to warm up.

(4) Turn SELECTIVITY switch to position 1. Turn AVC off, LIMITER off, BFO off, CALIBRATE off and AUDIO GAIN to position 0. Tune receiver to carrier frequency of signal generator.

(5) Turn RF GAIN to mid-range and synchronize scope. Two fairly symmetrical peaks should appear on the scope screen. If they do not, adjust receiver tuning, RF GAIN and oscilloscope controls until they do appear. Each of these peaks is essentially an i-f response curve.

(6) Rotation of the PHASING control to the left should cause a rejection notch to appear at one side of each peak. If this notch does not appear, set the PHASING control about one-eighth turn to the left of center and adjust the core in top of T102 (accessible through the right-hand hole in the crystal filter cover) until it does appear and is well-defined on the scope screen. Adjust until no evidence of a damped oscillation remains.

(7) Turn PHASING control about one-eighth turn to the right of center. The rejection notch should appear at the other side of each peak, and, without further adjustment, should be well-defined and without evidence of a damped oscillation. If this is not the case, adjust T102 core slightly.

(8) Repeat steps (4) and (5) until the notch obtained in one of the steps looks symmetrical with respect to the notch obtained in the other step and gives no evidence of a damped oscillation.

5.3.6. ALTERNATE BFO ALIGNMENT METHOD. - The following paragraphs describe how to align the BFO when a signal generator is not available. For the standard alignment procedure, which requires a signal generator, refer to paragraph 5.3.5. above for the set-up, and to 5.3.5.(h) for the procedure.

(a) Disconnect antenna from terminal at rear of chassis. Turn 100-kc crystal oscillator on and BFO on.

(b) Tune receiver to a 100-kc check point on bands 2 or 3. For example, tune receiver to 2.0 mc.

(c) Line up the knob with the panel mark and with the mid-range point of the BFO PITCH capacitor as follows: If the BFO PITCH knob has never been removed from the shaft during the life of the receiver, turn the knob until the knob mark lines up with the panel mark on the receiver. If the BFO PITCH knob has ever been removed from the shaft, adjust the core in T106 to produce a beat note. Turn BFO PITCH knob either to the right or to the left of the panel mark until the beat note's pitch rises to a maximum. Leave knob exactly at point of maximum pitch. BFO PITCH capacitor plates are now either all in or all out. Loosen set screws in BFO PITCH knob. Rotate knob on shaft

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until knob mark is 90° from panel mark. Tighten set screws. Turn knob to mark on panel. BFO PITCH is now at mid-range.

(d) Tune receiver at least 10 kc off of any 0.1 megacycle point on bands 2 or 3, and turn up AUDIO GAIN until a constant pitch beat note is audible. If the constant pitch beat note is not audible, adjust tuning core in top of T106 until it is. Make certain that this is the correct note by turning the KILOCYCLE dial ± 10 kc and noting whether the pitch of the beat note remains constant. This constant pitch beat note, which occurs only on bands 2 and 3, is produced by a small amount of fifth harmonic from the 100-kc oscillator that leaks into the i-f strip through the second mixer stage and beats with the signal from the BFO. Because of the superior strength of the calibration beat note in the vicinity of a 100-kc check point, this constant pitch beat note is most audible about half-way between check points.

(e) Adjust tuning core of T106 for zero beat. The BFO frequency is now 500 kc when the BFO PITCH knob is set at the fiducial mark on the panel.

5.3.7. 500 KC I-F PERFORMANCE MEASUREMENTS.

(a) Sensitivity. - The input to V106 at 500 kc should be within 25 to 40 uv for 4 volts at the diode load.

(b) Selectivity.

(1) Adjust the output level of the signal generator for 4 volts at the diode load. This voltage and the output level of the signal generator are the reference voltages.

(2) Increase the output level of the signal generator 6 db (twice the voltage). Determine the bandwidth by noting how far on either side of resonance the signal from the generator must be detuned in order to lower the diode voltage to 4 volts.

(3) Repeat step 2 for 60 db increase (1000 times the voltage) in signal input level.

(4) The overall selectivity specifications are:

a. Minimum selectivity

6 db	5.5 kc min.	6.5 kc max.
60 db	17.0 kc min.	20.0 kc max.

b. Maximum selectivity (crystal filter in)

6 db	0.2 kc min.	0.3 kc max.
60 db	0.2 kc min.	12.0 kc max.

5.3.8. ALIGNMENT OF DIALS WITH VFO

(a) MEGACYCLE DIAL POINTER. - It is very unlikely that the pointer on the MEGACYCLE dial will become inaccurate through normal use of the receiver. However, if the dial pointer has accidentally been slipped with respect to the cord, reset it as follows: Take off escutcheon plate; then rotate KILOCYCLE knob counterclockwise until it hits the mechanical stop. Then rotate it a fraction of a turn clockwise until the zero-zero mark lines up with the fiducial. From this point rotate KILOCYCLE knob exactly five turns clockwise. Grasp the dial cord and slide the MEGACYCLE pointer along it to the center frequency of the band. For example, if the receiver is set at band 2, set pointer exactly at 2.0 mc. Replace escutcheon plate.

(b) KILOCYCLE DIAL. - If the KILOCYCLE dial reading is incorrect first determine the magnitude and direction of the errors then correct them according to the procedures outlined below. To determine the nature of the errors, set the receiver on band 2 with the BAND CHANGE knob. Set KILOCYCLE fiducial line to center mark on escutcheon opening by turning ZERO ADJ knob. Set BFO exactly at 500 kc as in paragraph 5.3.6. Turn on the 100 kc oscillator with CALIBRATE switch. Turn KILOCYCLE knob to zero beat. Note the magnitude and direction of error in the KILOCYCLE dial reading. Tune receiver to 2.5 mc. With BFO still set at exactly 500 kc, turn KILOCYCLE knob to zero beat. Again, note magnitude and direction of error in KILOCYCLE dial reading.

(1) If the KILOCYCLE dial reading is incorrect by less than 3 kc in the same direction by the same amount at both ends of the MEGACYCLE dial, correct as follows:

a. Be sure BFO is set at 500 kc as in paragraph 5.3.6.

b. Tune the receiver to zero beat at the 100 kc check point nearest the dial setting at which maximum accuracy is desired. For example, if maximum accuracy is desired at 1.83 mc, tune to zero beat at 1.8 mc by turning the KILOCYCLE knob.

c. Set KILOCYCLE fiducial line to zero-zero on the KILOCYCLE dial by turning the ZERO ADJ knob.

(2) If the KILOCYCLE dial reading is incorrect by more than 3 kc in the same direction by the same amount at both ends of the MEGACYCLE dial, correct as follows:

a. Be sure BFO is set at 500 kc as in paragraph 5.3.6.

b. Tune to zero beat at 1.5 mc.

c. Set KILOCYCLE fiducial line to center index mark on escutcheon opening by turning ZERO ADJ knob.

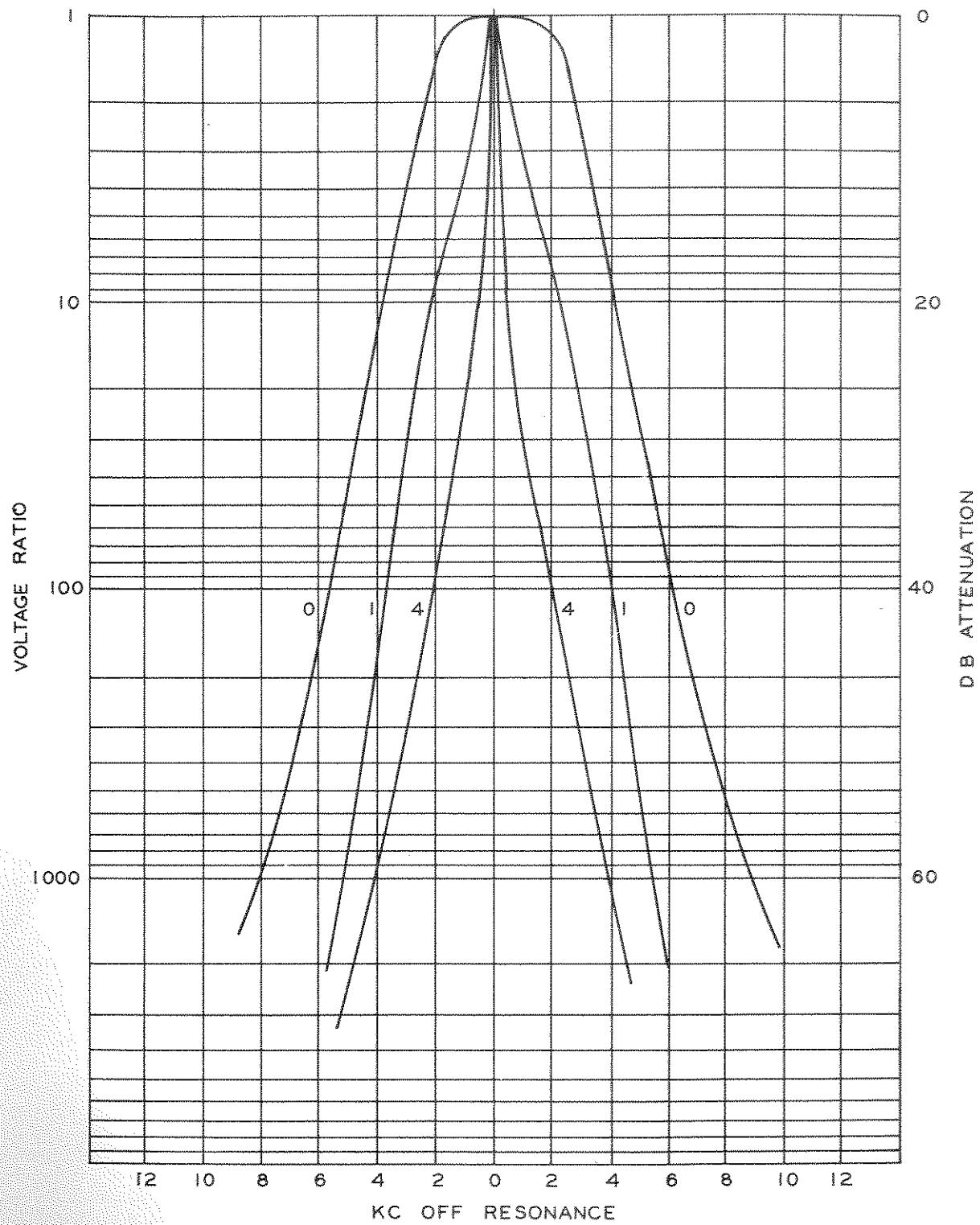


Figure 5-2. 51J-3 Selectivity Curves

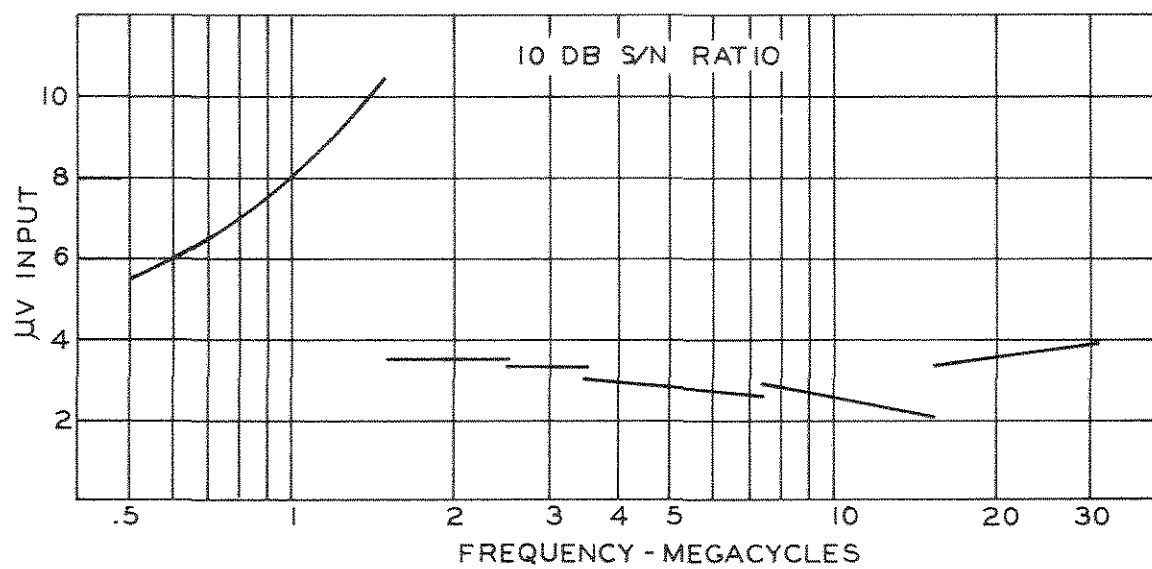


Figure 5-3. 51J-3 Sensitivity Curve

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d. Loosen set screws in the circular KILOCYCLE dial and set to zero-zero. Tighten set screws.

(3) If the two errors in the KILOCYCLE dial reading are either opposite in direction or different in size, it indicates that the VFO end points have drifted. Correct as follows:

a. Be sure BFO is set at 500 kc as in paragraph 5.3.6. Tune receiver to zero beat at 1.5 mc on band 2.

b. If the zero-zero mark on the KILOCYCLE dial lies within the lines on the escutcheon opening, set KILOCYCLE fiducial line to zero-zero on the KILOCYCLE dial by turning the ZERO ADJ knob.

c. If the zero-zero mark lies outside the lines on the escutcheon opening, loosen set screws in the KILOCYCLE dial. Set fiducial to the center line in the escutcheon opening. Rotate KILOCYCLE dial until zero-zero mark lines up with the fiducial. Tighten set screws.

d. Rotate KILOCYCLE knob approximately ten turns to zero beat. This procedure tunes the receiver to 2.5 mc.

e. Now note the error in the KILOCYCLE dial reading.

f. If this error is less than ± 3 kc, set the fiducial to 2.5 mc by turning the ZERO ADJ knob. This procedure sets the point of maximum accuracy at 2.5 mc. If maximum accuracy is desired at some other check point in the band, tune the receiver to zero beat at the desired check point. Then adjust fiducial to zero-zero on the KILOCYCLE dial.

g. If this error is more than ± 3 kc, refer to paragraph 5.3.15. for instructions.

(c) Check the VFO frequency against a known source to determine whether the VFO shaft has been displaced a full turn, and thereby has shifted the VFO frequency exactly 100 kc. Using a signal generator having an accuracy of $\pm 1\%$ or ± 20 kc or another 51J-3 receiver known to be properly aligned, check as follows.

(1) Set BFO exactly at 500 kc as in paragraph 5.3.6. Turn 100-kc oscillator OFF.

(2) If the signal generator is used, connect its output to pin 7 of V106 with a clip lead. Set generator at 2.0 mc. Tune receiver to zero beat at 2.0 mc. If the VFO shaft is displaced a full turn, zero beat will occur within 20 kc of 1.9 mc or 2.1 mc instead of 2.0 mc.

(3) If an accurately aligned 51J-3, hereafter called the test receiver, is used, couple the antenna jack of the test receiver to the

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output of the VFO that is being checked. Set BFO of test receiver at 500 kc. Turn on 100-kc oscillator in test receiver. Tune the receiver containing the VFO being checked to 2.0 mc. Tune the test receiver to zero beat at 2.5 mc. If the shaft of the VFO being checked is displaced a full turn, zero beat will occur at 2.4 mc or 2.6 mc instead of 2.5 mc.

(4) If steps (2) or (3) reveal that the VFO shaft is displaced a full turn, correct as follows.

a. Connect a clip lead from pin 7 of V106 to the 100-kc oscillator output at C173. Turn on 100-kc oscillator. With BFO set at 500 kc as in paragraph 5.3.6., tune receiver to zero beat at 2.5 mc. Loosen set screws in VFO coupler.

b. If zero beat occurred at 2.1 mc instead of at 2.0 mc in step (2), or at 2.4 mc instead of at 2.5 mc in step (3), the VFO frequency is 100 kc less than it should be. Correct by turning VFO shaft one full turn counterclockwise to zero beat.

c. If zero beat occurred at 1.9 mc in step (2) or at 2.6 mc in step (3) the VFO frequency is 100 kc more than it should be. Correct by turning VFO shaft one full turn clockwise to zero beat.

d. Tighten set screws in VFO shaft coupler.

5.3.9. VARIABLE I-F ALIGNMENT.

(a) Connect signal generator in series with a 47 ohm resistor and a 100 uuf capacitor to the ANTENNA terminal. Connect VTVM between diode load resistor R151 and chassis. Switch receiver to band 2. Set dial to read 1.6 mc. Set ANT TRIM to mid-range.

(b) Turn BFO on and set signal generator to zero beat at 1.6 mc. Turn BFO off. Adjust output of signal generator to give some value of diode load voltage below 5 volts. Tune slugs marked 1.6 (in L116, L118 and L102) for a maximum indication while adjusting the signal generator to keep diode load voltage below 5 volts.

(c) Set dial to read 2.4 mc. Set generator to zero beat at 2.4 mc with BFO. Turn BFO off. Tune adjustments marked 2.4 (trimmer capacitors C174, C180, and C104) for a maximum indication, keeping diode load voltage below 5 volts.

(d) Repeat tuning procedures at 1.6 and 2.4 mc until no further increase in output can be obtained.

NOTE

IN THE FOLLOWING RF ALIGNMENT PROCEDURES KEEP DIODE LOAD VOLTAGE BELOW 5 VOLTS AS IN PARAGRAPH 5.3.9.(b) ABOVE.

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5.3.10. RF ALIGNMENT BAND 3.

(a) Connect the signal generator and VTVM as in step 5.3.9.(a). Set bandswitch to band 3.

(b) Set dial to read 2.6 mc. Set signal generator to zero beat at 2.6 mc with BFO. Turn BFO off. Adjust tuning cores marked 2.6 (in L117, L119 and L103) for a maximum indication.

(c) Set dial to read 3.4 mc. Set signal generator to zero beat at 3.4 mc with BFO. Turn BFO off. Adjust trimmer capacitors marked 3.4 (C176, C182 and C106) for a maximum indication.

(d) Repeat tuning procedures at 2.6 and 3.4 mc until no further increase in output can be obtained.

5.3.11. RF ALIGNMENT BANDS 4-7.

(a) Connect signal generator and VTVM as in step 5.3.9.(a). Set bandswitch to band 4.

(b) Set dial to read 4.0 mc. Set signal generator to zero beat at 4.0 mc with BFO. Turn BFO off. Adjust tuning cores marked 4.0 (in L104, L107 and L111) for maximum indication.

(c) Set bandswitch to band 7. Set dial to read 7.0 mc. Set signal generator to zero beat at 7.0 mc with BFO. Turn BFO off. Tune trimmer capacitors marked 7.0 (C108, C120 and C128) for maximum indication.

(d) Repeat tuning procedures at 4.0 mc and 7.0 mc until no further increase in output can be obtained.

5.3.12. RF ALIGNMENT BANDS 8-15.

(a) Connect signal generator and VTVM as in step 5.3.9.(a).

(b) Set bandswitch to band 8. Set dial to 8.0 mc. Set signal generator to zero beat with BFO at 8.0 mc. Turn BFO off. Tune trimmer capacitors marked 8 (C110, C122 and C130) for maximum indication.

(c) Set bandswitch to band 15. Set dial to read 15.0 mc. Set signal generator to zero beat with BFO at 15.0 mc. Turn BFO off. Tune trimmer capacitors marked 15 (C110, C122 and C130) for maximum indication.

(d) Repeat tuning procedures at 8.0 mc and 15.0 mc until no further increase in output can be obtained.

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5.3.13. RF ALIGNMENT BANDS 16-30.

- (a) Connect signal generator and VTVM as in step 5.3.9.(a).
- (b) Set bandswitch to band 16. Set dial to 16.0 mc. Set signal generator to zero beat with BFO at 16.0 mc. Turn BFO off. Adjust tuning cores marked 16 (in L106, L109 and L113) for a maximum indication.
- (c) Set bandswitch to band 30. Set dial to 30.0 mc. Set signal generator to zero beat with BFO at 30.0 mc. Turn BFO off. Adjust trimmer capacitors C124, C132 and ANT TRIM for a maximum indication.
- (d) Repeat tuning procedures at 16.0 and 30.0 mc until no further increase in output can be obtained.

5.3.14. RF ALIGNMENT BAND 1.

- (a) Connect signal generator and VTVM as in step 5.3.9.(a).
- (b) Set bandswitch to band 1. Set dial to 0.6 mc. Set generator to zero beat with BFO at 0.6 mc. Turn BFO off. Adjust core in L114 so that it is in approximately the same position in the inductor as the cores in L116 and L118. Adjust cores marked 0.6 (in L101 and L110) for a maximum indication. Adjust trimmer capacitor marked 0.6 (C140) for a maximum indication.

NOTE

TWO PEAKS MAY BE FOUND WHEN TUNING C140. USE THE PEAK THAT REQUIRES THE HIGHER VALUE OF CAPACITANCE. Refer to C140 in figure 5-1.

- (c) Set dial to 1.4 mc. Set signal generator to zero beat with BFO at 1.4 mc. Turn BFO off. Tune trimmers marked 1.4 (C102 and C119) for a maximum indication. Adjust core marked 1.4 (in L115) for a maximum indication.
- (d) Repeat tuning procedures at 0.6 and 1.4 mc until no further increase in output can be obtained.

5.3.15. VFO ALIGNMENT.

(a) GENERAL. - During manufacture of the VFO the frequency-determining elements are hermetically sealed within the outer cylindrical cover while they are being held at a high temperature. This drives out practically all moisture and creates a partial vacuum within the sealed compartment. Because of the method of fabrication and the efficiency of design, it is quite unlikely that the VFO will become misaligned through normal use or

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treatment. However, if it does become sufficiently misaligned, as indicated by the procedure outlined in paragraph 5.3.8.(b)(3), it must be returned to the factory for permanent alignment. Because alignment procedure involves breaking of the hermetic seal by removal of a small plug, the future stability of the VFO will be seriously impaired if conditions under which it was manufactured are not duplicated during alignment. Therefore, it is possible to align the VFO only temporarily without sending it back to the factory. If the VFO is to be sent back to the factory refer to paragraph 5.4. for instructions on removal. This temporary alignment can be performed by a qualified and properly equipped service technician, but should be attempted only in case of emergency. All components not contained within the sealed cover can be maintained in the field.

WARNING

DO NOT, UNDER ANY CIRCUMSTANCES, ATTEMPT TO REMOVE THE OUTER CYLINDRICAL COVER. THIS NOT ONLY BREAKS THE HERMETIC SEAL BUT EXPOSES THE FREQUENCY CORRECTOR MECHANISM AND THE CAREFULLY COMPENSATED FREQUENCY-DETERMINING ELEMENTS.

(b) PROCEDURE.

(1) Before aligning the VFO be sure that the BFO is set at 500 kc as in paragraph 5.3.6., that the 500-kc i-f channel is aligned and that the 100-kc oscillator is turned off.

(2) Use a signal generator having an output of 1.5 mc with better than ± 25 kc accuracy.

(3) Loosen set screws in the flexible VFO coupler, and slide the coupler hubs apart. Remove the receiver's front panel and the VFO mounting screws. Pull out the VFO and carefully allow it to hang on the connecting wires. Mount a small circular dial on the VFO shaft. This dial must have a linear scale from 0 to 100 completely around its periphery. Affix a small wire for use as a pointer on one of the VFO mounting screws. One division of the dial will equal one kilocycle.

(4) Turn the receiver ON and short the antenna terminal to chassis. Because none of the receiver's variable tuned circuits are used in this procedure, leave the receiver dials at whatever frequency they happen to be on when the receiver is turned on.

(5) Couple the 1.5 mc output from the signal generator to pin 1 of V106.

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(6) Find the low frequency endpoint (2.0 mc) of the VFO by turning the VFO shaft clockwise to the last zero beat obtainable in that direction.

CAUTION

DO NOT FORCE THE VFO SHAFT BY ATTEMPTING TO TURN IT FURTHER WHEN IT REACHES THE STOP AT EITHER END OF THE RANGE.

(7) The VFO setting is now within 20 kc of 2.0 mc and must be adjusted more accurately as follows. Uncouple signal generator from pin 1 of V106. Connect a clip lead from the 100 kc oscillator at C173 to pin 1 of V106. Turn 100-kc oscillator on. Carefully rotate VFO shaft to the nearest zero beat. VFO setting is now exactly 2.0 mc. Place VFO dial pointer at zero, being careful to retain the zero beat setting.

(8) Rotate the VFO shaft exactly 10 turns in a counter-clockwise direction, counting exact turns with the VFO shaft dial. Find zero beat by turning the VFO shaft a few divisions toward either side of the 10-turn mark.

(9) If zero beat occurs on either side of the 10-turn mark, note the magnitude and direction of the error by counting divisions between zero and the pointer. Multiply this number of error divisions by 1.5.

(10) If zero beat occurs at less than 10 turns, rotate the VFO shaft counterclockwise by the number of divisions arrived at in step (9) (1.5 times the error divisions).

(11) If zero beat occurs at more than 10 turns, rotate the VFO shaft clockwise by the number of divisions arrived at in step (9) (1.5 times the error divisions).

(12) Remove the hex plug from the front of the oscillator. Using the outer part of the special VFO adjustment tool illustrated in figure 5-7, loosen the lock nut that is visible when the hex plug is removed. Insert the screwdriver portion of the VFO tool into the outer portion. Adjust the trimmer screw by turning the screwdriver until zero beat is again reached. Tighten lock nut, being careful to retain zero beat.

(13) The high and low end (2.0 and 3.0 mc) zero beat positions should now be exactly ten turns apart. If this is not the case, repeat the above procedure until they are. It will be necessary to zero the dial pointer at the initial zero beat position each time this procedure is repeated. Be sure to tighten the lock nut after making each trimmer adjustment. Be careful not to lose the endpoints by counting incorrectly or forgetting the count. If they are lost turn off the 100-kc oscillator and start the procedure over at step (5).

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(14) After separating the 2.0 and 3.0 mc endpoints of the VFO by exactly 10 turns, replace the hex plug, put the VFO in the receiver and replace the front panel. Align the receiver dials with the VFO according to the procedure outlined in paragraph 5.3.8.(b)(2). It is not necessary to readjust the r-f and i-f amplifiers for small changes in the VFO adjustment.

(c) EXAMPLES. - The following examples illustrate the procedure outlined in paragraph (b).

NOTE

DO NOT ATTEMPT TO FOLLOW THESE EXAMPLES AS INSTRUCTIONS. THEY ARE INCLUDED FOR ILLUSTRATIVE PURPOSES ONLY.

(1) Zero the pointer at the low frequency endpoint (2.0 mc) of the VFO. Read zero on the shaft dial. Rotate shaft exactly 10 turns counterclockwise. Again read zero on the dial. A beat note is audible at this setting. Find zero beat by turning VFO shaft by 4 divisions clockwise. This indicates that the endpoints are 4 divisions less than 10 turns apart. Multiply the 4 error divisions by 1.5 to arrive at 6. Rotate VFO shaft counterclockwise by 6 divisions since zero beat occurs at less than 10 turns. Turn trimmer screw to zero beat. Rotate VFO shaft exactly 10 turns clockwise to check whether the endpoints are now exactly 10 turns apart. If they are not, repeat procedure in paragraph (b) until they are.

(2) Zero the pointer at the low frequency endpoint (2.0 mc) of the VFO. Read zero on the shaft dial. Rotate shaft exactly 10 turns counterclockwise. Again read zero on the dial. A beat note is audible at this setting. Find zero beat by turning VFO shaft by 5 divisions counterclockwise. This indicates that the endpoints are 5 divisions more than 10 turns apart. Multiply the 5 error divisions by 1.5 to arrive at 7.5. Rotate VFO shaft clockwise by 7.5 divisions since zero beat occurs at more than 10 turns. Turn trimmer screw to zero beat. Rotate VFO shaft exactly 10 turns clockwise to check whether the endpoints are now exactly 10 turns apart. If they are not, repeat procedure in paragraph (b) until they are.

5.3.16. ADJUSTMENT OF L-124. - Reach L-124 from the bottom of the chassis. Adjust as follows.

(a) Turn BFO ON and tune in the spurious signal at 1250 kc.

(b) Adjust L-124 for greatest attenuation of the spurious signal.

5.4. COMPLETE VFO REMOVAL. - If the VFO has to be completely removed from the receiver for servicing, proceed as follows.

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(a) Remove the front panel and allow it to swing forward on the wires. (See paragraph 5.6.2. for detailed instructions on removing the front panel.)

(b) Loosen set screws in the flexible coupler. Pull the coupler apart and remove the center disc.

(c) Mark the VFO connecting wires so that they may be reconnected correctly. Unsolder the wires.

(d) Remove the three screws that hold the VFO to the chassis.

(e) Slide the VFO back and tip the rear downward.

(f) Pull the VFO from the receiver.

5.5. DIAL BULB REPLACEMENT. - The lights for the slide rule dial are mounted in sockets which are clipped to the metal structure above the dial. To replace light bulbs slide the clips off the metal structure and pull out the sockets. Press down on the bulb slightly and turn it a fraction of a turn counterclockwise. When replacing the sockets, press the wires up into the channel. To remove the KILOCYCLE dial light, reach under the drum of the MEGACYCLE dial and grasp the frame of the dial light socket; then pull it back far enough to replace the bulb.

5.6. DIAL AND BAND CHANGE GEAR MAINTENANCE.

5.6.1. GENERAL. - The replacing and synchronizing of gears in the dial and band change mechanism of this receiver can be a difficult job. It is recommended that the unit be sent to the factory for servicing should any major repairs be required.

WARNING

IF DISASSEMBLY OF THE GEAR UNIT IS CONTEMPLATED,
INSTRUCTIONS IN PARAGRAPHS 5.6.2. and 5.6.3.
MUST BE FOLLOWED CLOSELY OR IT WILL BE IMPOSSIBLE
TO SYNCHRONIZE THE GEARS UPON REASSEMBLY.

5.6.2. DISASSEMBLY OF GEAR BOX.

(a) If the gear box is to be returned to the factory for servicing, proceed as follows.

(1) Set the receiver on its back. Remove the following knobs: SELECTIVITY, PHASING, BFO PITCH, BAND CHANGE, KILOCYCLE Tuning, and ANT TRIM. Remove the collar, tension washer and flat washer from the KILOCYCLE shaft. Remove the screws that fasten the front panel to the chassis. Lift the panel off and carefully allow it to hang to one side on the cable wires.

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- (2) Remove the right-hand end bracket from the chassis.
- (3) Loosen set screws in the following couplers: VFO, r-f slug rack and i-f slug rack shafts, all accessible from the top of the receiver, and two band change shafts, accessible from the bottom.
- (4) Remove the VFO mounting screws and the gear box mounting screws. Lift the gear box from the receiver.
 - (b) If repairs are to be made in the field, the gear box may either be removed from the receiver or left in, depending on the extent of repairs. If the box is to be removed, turn the MEGACYCLE knob to its clockwise stop and the KILOCYCLE knob to its counterclockwise stop, and follow the instructions in paragraph 5.6.2.(a); then proceed according to the following steps. If the box is to be left in the receiver, perform steps (1) and (2) under paragraph 5.6.2.(a); then proceed according to the following steps. Refer to figures 4-2 and 5-4 for location of gears and shafts.
 - (1) Turn shaft G (BAND CHANGE) clockwise to the stop below band 1. Turn shaft A counterclockwise to the stop.
 - (2) Scribe a mark across the 85-tooth spider gear that carries the planetary gears, and across the 90-tooth stop-pin gear, using the top of the front gear panel as a guide.
 - (3) Scribe a radial mark, precisely under the Geneva wheel detent, on the 144-tooth gear that has two stop pins attached.
 - (4) Using the circumference of the Geneva wheel as a guide, scribe a mark on the 85-tooth gear that drives the Geneva wheel.
 - (5) Scribe a mark through the edge of the small dial cord pulley and the front gear panel.
 - (6) Remove pin from hub of large dial cord pulley.
 - (7) Remove large dial cord pulley and gear.
 - (8) Remove small dial cord pulley.
 - (9) Remove retaining ring from shaft I (shown as shaft Z in the front view of gear plate in figure 5-4).
 - (10) Using a pair of right angle TRUARC pliers or two bent (right angle) scribes, remove retaining ring from shaft F.
 - (11) Measure and record the length of loading spring using a pair of dividers.

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(12) Remove four mounting screws from front gear panel.

(13) Remove front gear panel, being very careful not to let shafts ride up with plate. While removing this panel, do not allow gears to unmesh or rotate.

(14) Keep shim washers with respective gears or shafts.

(15) Before moving or disengaging any gears other than the 90-tooth gear on shaft F, scribe a line through detent spring, 48-tooth detent gear, and rear gear panel, and another line through the 52-tooth gear on shaft E and rear gear panel.

(16) Mark all gears being removed in such a manner that they may be identified later for reassembly.

(17) If the overtravel coupler is removed, note that the disc and gear are detented. Do not lose detent ball.

(18) Make all necessary repairs. If any parts that have been scribed are to be replaced, be sure to scribe the new parts in exactly the same manner before placing them in the equipment. If the loading cord is to be replaced, form a small loop at one end of each of the two pieces to provide anchors for the spring. Push free ends of the cords through the proper pulley-holes. Knot the free ends after allowing for five inch lengths of cord between the loops and knots. Coat the knots with Duco cement.

5.6.3. REASSEMBLY OF GEAR BOX. - The following procedure assumes that all gears have been removed, that all repairs have been made, and that the gear and shaft assemblies have been reassembled after repairs were made.

(a) Use AN-G-25 grease on all bearing surfaces during assembly.

(b) If the 74-tooth idler gear whose shaft is riveted to the rear gear panel was removed, replace it first.

(c) Replace 48-tooth gear and shaft K assembly and shim washers, item J. Replace retaining ring.

(d) Replace 52-tooth gear and shaft E assembly and washer, item G. Line up scribe marks on gear and rear panel. Replace retaining ring.

(e) Replace 48-tooth detent gear, shaft C, detent, and 16-tooth gear assembly. Line up marks on rear panel, 48-tooth gear, and detent spring.

(f) Replace 85-tooth spider gear, 45-tooth, and 25-tooth planetary gear assembly, and shim washer, item AP, on shaft C. Do not move other gears already lined up with the scribe marks.

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(g) Replace 48-tooth gear, shaft B, 24-tooth gear assembly, and washers, items C and D as follows:

Wind the loading cord about 1-1/2 turns clockwise on the pulley that is attached to the 52-tooth gear on shaft E. Do not move gears while doing this. Hook spring onto both halves of the loading cord. Insert shaft B into hole on rear plate, but do not yet engage the 48-tooth gear with the detent gear. While holding the 52-tooth gear and shaft E assembly, and the detent gear at their respective scribe marks, rotate shaft B counter-clockwise until loading spring stretches to the length measured before disassembly. Engage 48-tooth gear with detent gear while maintaining tension on the loading spring.

(h) Replace the 72-tooth gear and 50-tooth sun gear assembly and shim washer, item W, while holding 85-tooth spider gear so that the scribe mark on it is horizontal (parallel with the top and bottom edges of the gear panels). Keep all other gears set at the scribe marks.

(i) Reassemble overtravel disc with the 144-tooth overtravel gear. Detent the two together with detent ball. Use AN-G-25 grease to hold ball in place.

(j) Replace overtravel assembly, lining up mark on overtravel gear with notch on Geneva detent spring.

(k) Replace 85-tooth gear, shaft G, and 16-tooth gear assembly, lining up arcuate scribe mark with circumference of overtravel gear. (This mark will later line up with the Geneva wheel, but at present it is concentric with the overtravel gear. Make sure that alignment described in step (h) is maintained.

(l) Replace Geneva wheel and 33-tooth gear assembly and shim washer, item D. Be sure Geneva drive pin is engaged with slot in the Geneva wheel while the Geneva wheel detent is engaged, and that the arcuate scribe mark on the 85-tooth drive gear lines up with the circumference of the Geneva wheel.

(m) Replace 90-tooth gear and shaft I assembly, and washer, item G. Position is not critical.

(n) Lay the 90-tooth stop-pin gear in position with the scribe mark horizontal across the top, and collinear with scribe mark on the 85-tooth spider gear (parallel to the top and bottom edges of the gear panels).

(o) Replace front gear panel as follows: While sliding the panel into position, slide the 90-tooth stop-pin gear on its shaft which is attached to the front panel, being careful to keep scribe mark lined up with the mark on the 85-tooth spider gear. Also keep arcuate mark on the 85-tooth

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Geneva drive gear lined up with the circumference of the Geneva wheel. Further, keep the mark on the 144-tooth overtravel coupler gear lined up with notch in the Geneva wheel detent. Replace screws in front gear panel.

(p) Check operation of the BAND CHANGE gear. If the gear box has been removed from the receiver, make the check while holding the gear box in a horizontal plane with the front gear panel facing down, so that the 90-tooth stop-pin gear will not fall off during the check. If the gear box has not been removed from the receiver, replace the retaining ring on the 90-tooth stop-pin gear shaft before making the check. Then, in either case, proceed as follows:

(1) Shaft G should now be against the clockwise stop, and should detent when turned counterclockwise approximately 45° . The ball on shaft C will now detent shaft G every 180° .

(2) When shaft G is turned counterclockwise $7\frac{1}{2}$ revolutions, or 15 detent positions from the first detent position, the pin in the 144-tooth gear on shaft H (figure 5-4), and the radial pin on the overtravel disc rotate clockwise until the radial pin just touches or is about to touch the pin in the rear gear panel. Further rotation of shaft G causes the pin in the gear to leave the radial pin that was stopped by the pin in the rear gear panel. Thus the overtravel coupler output shaft, which drives r-f switches S101 through S107 (figure 4-2), rotates 300° for the first 16 detent positions of shaft G and remains at that setting for further counterclockwise rotation of shaft G.

(3) Shaft G should rotate 14 more detent positions or 7 revolutions from the sixteenth detent position, and should hit the counterclockwise stop approximately 45° past the thirtieth detent position. If the stop pins intersect before this, adjust them by changing phase relations of the gears at points 1, 2, and 3, shown in figure 5-4. Before deciding to change the relative positions of these gears, double check the conditions in steps (1), (2) and (3). If instructions in paragraphs 5.6.2. and 5.6.3. were followed precisely, operation of the BAND CHANGE gear train should meet the conditions set forth in these steps.

(4) The Geneva wheel should turn one notch when shaft G turns counterclockwise from an even-numbered to an odd-numbered detent position. (Count the first detent position from the clockwise stop as number 1.) Thus shaft I should rotate through 14 positions, or 280° , for 30 detent positions, or $14\frac{1}{2}$ turns, of shaft G. The initial position of shaft I should correspond to detent positions 1 and 2 of shaft G, the second shaft I position should correspond to detent positions 3 and 4 of shaft G, and so on through to the thirtieth detent position of shaft G.

(q) After accomplishing proper operation of the BAND CHANGE gear train, replace the retaining ring on the 90-tooth stop-pin gear shaft.

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(r) Replace large dial cord pulley and gear assembly as follows: Turn shaft A to counterclockwise stop. Make sure that the 52-tooth gear on shaft E and the 48-tooth detent gear on shaft C are still set at their respective scribe marks. Place pulley and gear assembly far enough on shaft B to engage the rear section of the split gear with the 15-tooth gear on shaft A. Be sure that groove-pin holes on shaft and hub are lined up and that the pulley slot is within 45° of the position shown in figure 5-4. Rotate front section of split gear so that springs stretch to $3/4$ inches. Engage front section with 15-tooth gear on shaft A. Replace groove pin and tighten set screw.

(s) Check operation of loading cord by turning shaft A clockwise. Be sure that the loading spring travels from the drum on shaft E to the same relative position at the drum on shaft B when shaft A hits the clockwise stop. The loading spring should not touch either drum at either end of its travel.

(t) Replace small dial cord pulley. Line up with scribe mark and tighten set screw.

(u) Rotate shaft A to its counterclockwise stop, and shaft G to its clockwise stop; then replace the gear box in the receiver. Reconnect couplers; then replace dial cords, front panel and right-hand end bracket. Replace flat washer, tension washer and collar on KILOCYCLE shaft. Push collar against tension washer until tension washer is almost flat; then tighten collar set screws. Replace knobs.

5.7. RF TUNER ASSEMBLY MAINTENANCE.

5.7.1. GENERAL. - The r-f tuner assembly will require very little maintenance. However, should it be taken apart for any reason, the following information will indicate the correct positions of the cams.

5.7.2. POSITIONS OF CAMS. - The front plate of the slug rack assembly contains three alignment holes as indicated in figure 5-5. If the cams are correctly synchronized, the tips of the front cams will be directly opposite these holes. Use a dental mirror to accurately inspect the position of the cam tips in relation to the alignment holes. If a dental mirror is not available, check positions and operation of the cams in the following manner.

(a) Turn BAND CHANGE knob to band 30. Turn KILOCYCLE knob clockwise to stop.

(b) Viewing the right-hand slug-moving cam from the front, the slug table cam rider should be approximately $1/16$ inches to the right of the cam tip. The cam rider should descend this same right-hand edge when step (c) is performed.

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(c) Turn BAND CHANGE knob to band 16. Turn KILOCYCLE knob counter-clockwise to stop. The cam rider should still be on the same side of the cam as in step (b), and not bottomed in the low spot of the cam.

(d) Turn BAND CHANGE knob to band 15. Turn KILOCYCLE knob clockwise to stop.

(e) Viewing the center cam from the front, the cam rider should be approximately $1/32$ inches to the left of the cam tip. The cam rider should descend this same left-hand edge when step (f) is performed.

(f) Turn BAND CHANGE knob to band 8. Turn KILOCYCLE knob counter-clockwise to stop. The cam rider should still be on the same side of the cam as in step (e) and not bottomed in the low spot of the cam.

(g) Turn BAND CHANGE knob to band 7. Turn KILOCYCLE knob clockwise to stop.

(h) Viewing the left-hand cam from the front, the cam rider should be approximately $1/32$ inches to the right of the cam tip. The cam rider should descend this same right-hand edge when step (i) is performed.

(i) Turn BAND CHANGE knob to band 4. Turn KILOCYCLE knob counter-clockwise to stop. The cam rider should still be on the same side of the cam as in step (h) and not bottomed in the low spot of the cam.

(j) Before putting the receiver into operation again, investigate the electrical alignment of the stages affected by any repair operations, and check the synchronization of the slug rack with the BAND CHANGE mechanism.

5.8. DIAL CORDS.

5.8.1. MEGACYCLE POINTER CORD. - Refer to figure 5-6. Remove the front panel according to directions in paragraph 5.6.2.(a). If the cord is to be replaced, use $36-5/8$ inches of Collins number 432 1009 00 nylon-covered cord.

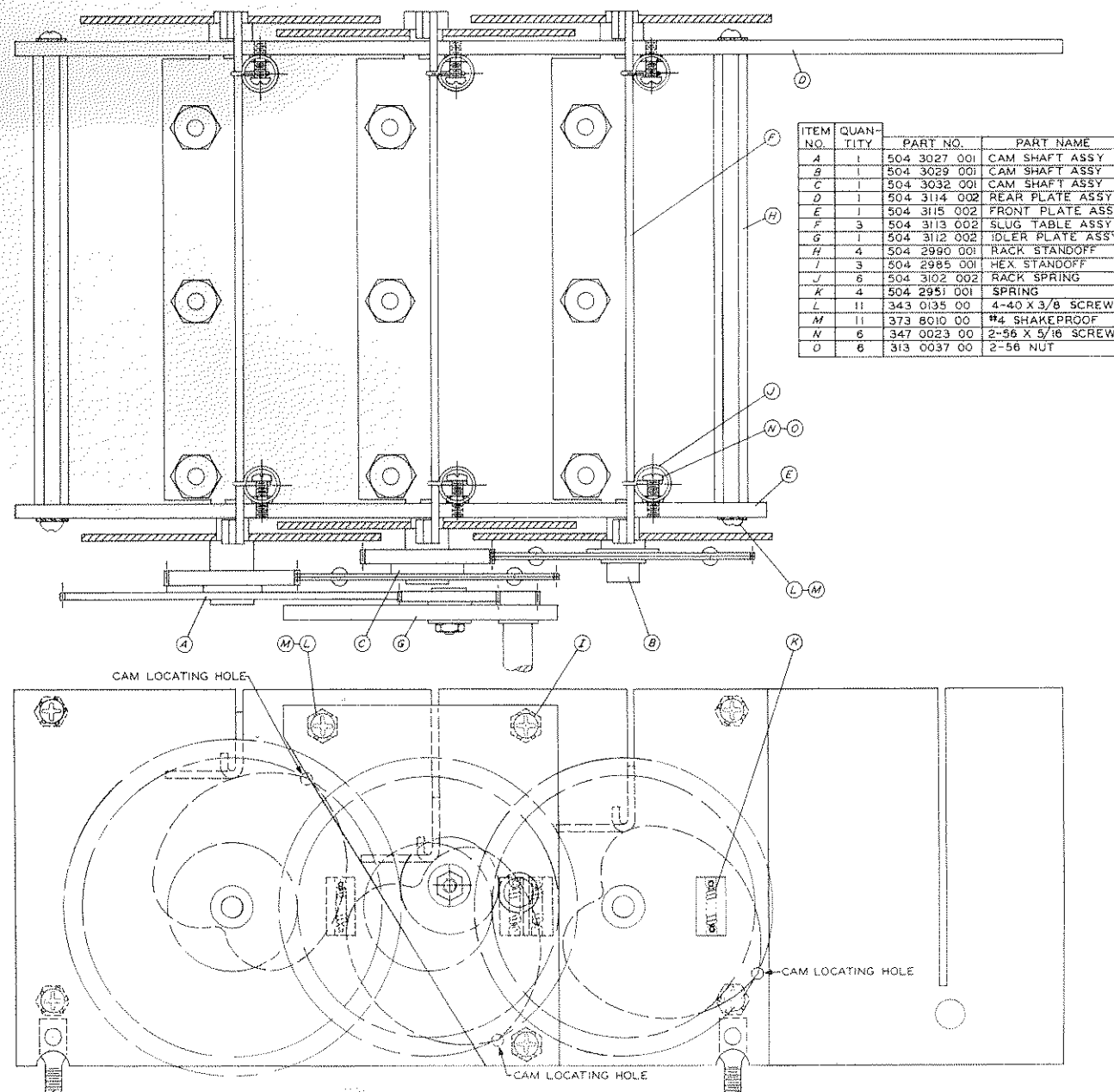
(a) Turn KILOCYCLE shaft counterclockwise to stop.

(b) Tie a loop in the cord. Loop the cord over the tab at point X in figure 5-6.

(c) Wind cord about one-half turn clockwise on pulley A, continue to pulley B, pointer, pulley C, and back to pulley A.

(d) Wind cord about $1-1/2$ turns clockwise around pulley A. Fasten cord to the spring on pulley A with spring at full tension.

Figure 5-5. 51J-3 R.F. Slug Rack



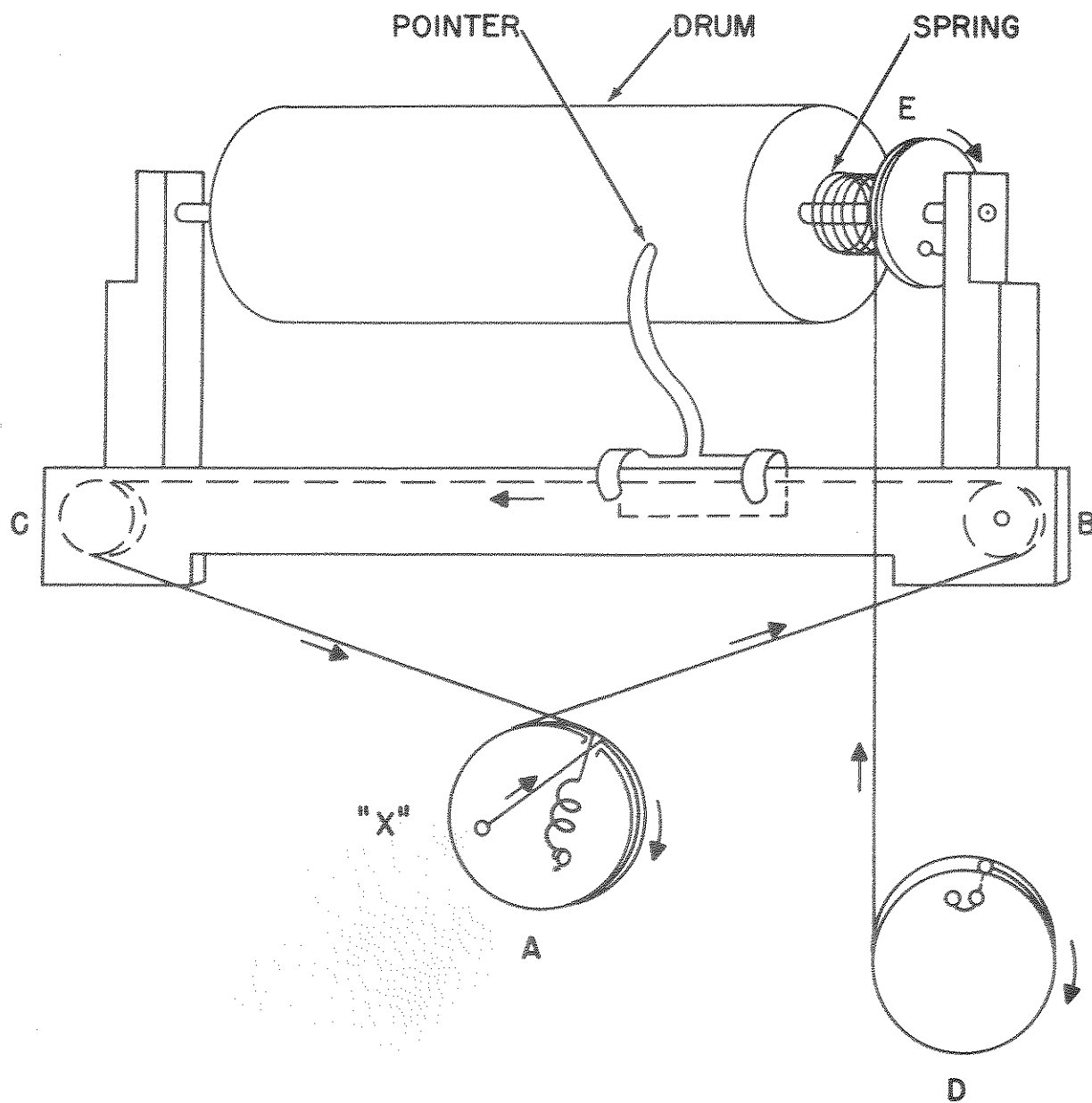


Figure 5-6. 51J-3 Dial Cord Arrangement

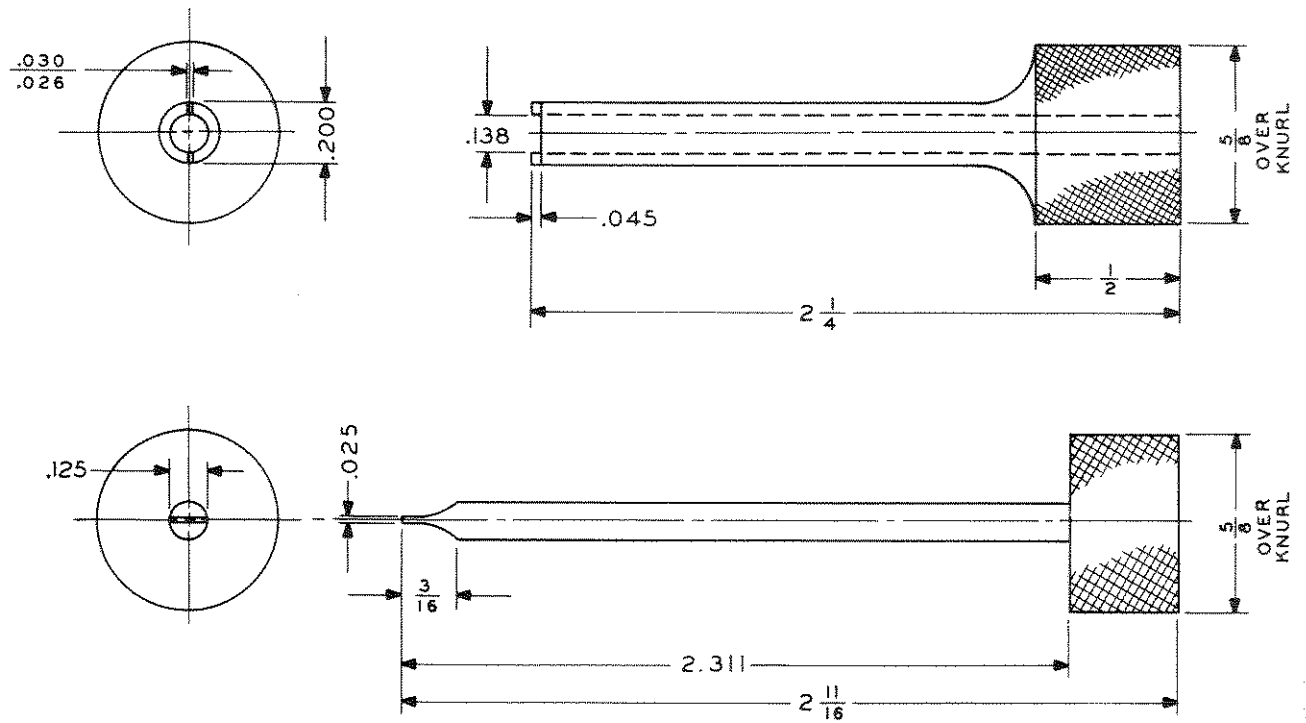


Figure 5-7. 51J-3 V.F.O. Adjustment Tool

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(e) Replace front panel, KILOCYCLE shaft flat washer, tension washer and collar, and knobs.

5.8.2. DRUM CORD. - If the drum cord has jumped the pulleys, restring it without removing the front panel. If the cord is broken, remove the front panel as in paragraph 5.6.2. Use 27 inches of Collins 432 1009 00 nylon-covered cord for replacement.

(a) Turn BAND CHANGE knob to band 30.

(b) Turn pulley E, figure 5-6, about one-half turn and hold tension of spring.

(c) Insert cord in pulley D and knot it. Wind cord about three-fourths of a turn on pulley D; extend to pulley E, and wind it 1-1/2 turns or more around pulley E as needed. Insert cord in hole and knot it.

(d) Replace panel and knobs.

(e) Loosen set screw in drum hub and turn drum until 30-mc band is centered in the escutcheon opening; then tighten set screw.

TABLE 5-1

51J-3 TUBE SOCKET RESISTANCE AND VOLTAGE MEASUREMENTS

All measurements taken from socket pins to ground, resistance measurements taken with no a-c input, power on, gain controls on full, AVC on, all other switches off unless otherwise noted.

Voltage measurements taken with 115 volt a-c input, power on, no input signal, r-f gain full on, audio gain off, AVC on, all other switches off unless otherwise noted. Voltages measured with vacuum tube voltmeter, 11 megohms input resistance.

TUBE	PIN	RESISTANCE	VOLTAGE
V101 6AK5	1	1.1 Meg	-1.2
	2	Gnd	Gnd
	3	Gnd	Gnd
	4	Fil	AC 6.3
	5	58K	+58 Band 1
			+190 Bands 2 - 3
			+125 Bands 4 - 30
	6	74K	+100
	7	Gnd	Gnd

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TUBE	PIN	RESISTANCE	VOLTAGE
V102 6BE6	1	22	0 Small indication on Bands 2 & 3
	2	470	+1.4
	3	Gnd	Gnd
	4	Fil	AC 6.3
	5	43K	+180 Band 1 Small indication Bands 2 - 3 Bands 4 - 30
	6	88K	+210
	7	330K	+47 -1.3 to -4.5
V103	1	100K	-1.3 Band 1 -2. Band 2 -0 Band 3 - 30
	2	470	+1.8
	3	Gnd	Gnd
	4	Fil	AC 6.3
	5	42K	+210 Band 1 0 Bands 2 - 30
	6	74K	+85 Band 1
	7	.1	+70 Bands 2 -30 0
V104 6BA6	1	680K	0 Calibrate Off -24 Calibrate On
	2	Inf Calibrate Off 4700 Calibrate On	+60 Calibrate Off +7.2 Calibrate On
	3	Fil	AC 6.3
	4	Gnd	Gnd
	5	270K	+170 Calibrate Off +80 Calibrate On
	6	150K	+175 Calibrate Off +64 Calibrate On
	7	Inf Calibrate Off 4700 Calibrate On	+60 Calibrate Off +7.2 Calibrate On
V105 6AK5	1	100K	-10 to -30
	2	8	+.1
	3	Gnd	Gnd
	4	Fil	AC 6.3
	5	90K	+39 Bands 1 - 2

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TUBE	PIN	RESISTANCE	VOLTAGE
	6	76K	+165 Bands 3 - 12 +39 Bands 13 - 0 +105 Bands 1 - 2 +115 Bands 3 - 12 +105 Bands 13 - 30 +.1
	7	8	
V106 6BE6	1 2 3 4 5 6 7	100K 470 Gnd Fil 42K 73K .4	-.2 +2.6 Gnd AC 6.3 +205 +82 0
V107 6BA6	1 2 3 4 5 6 7	58K Gnd Gnd Fil 40K 26K Gnd	-1.4 Gnd Gnd AC 6.3 +155 +47 Gnd
V108 6BA6	1 2 3 4 5 6 7	58K Gnd Gnd Fil 38K 26K Gnd	-1.4 Gnd Gnd AC 6.3 +160 +50 Gnd
V109 6BA6	1 2 3 4 5 6 7	58K 30 Gnd Fil 38K 85K 30	-1.4 +.03 Gnd AC 6.3 +175 +90 +.03

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TUBE	PIN	RESISTANCE	VOLTAGE
V110 12AX7	1	550	-56
	2	550	-56
	3	100K	-53
	4	Fil	AC 6.3
	5	Fil	AC 6.3
	6	100K	-2.4
	7	100K	-2.4
	8	Gnd	Gnd
	9	Gnd	Gnd
V111 12AU7	1	48K	-1.4
	2	700K	-52
	3	2600	-44
	4	Fil	AC 6.3
	5	Fil	AC 6.3
	6	42K	+195
	7	100K	0
	8	1000	+6
	9	Gnd	Gnd
V112 12AX7	1	33K	-.8
	2	33K	-.8
	3	33K Limiter Off	-.8 Limiter Off
		1 Meg Limiter On	-.3 Limiter On
	4	Fil	AC 3.4
	5	Fil	AC 6.3
	6	260K	+135
	7	500K	0
	8	3300	+1.2
	9	Gnd	0
V113 6AQ5	1	NC	NC
	2	Gnd	Gnd
	3	Gnd	Gnd
	4	Fil	AC 6.3
	5	40K	+220
	6	40K	+210
	7	100K	-12.5

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TUBE	PIN	RESISTANCE	VOLTAGE
V114 6BA6	1	100K	-.5 BFO Off -10 BFO On
	2	Gnd	Gnd
	3	Gnd	Gnd
	4	Fil	AC 6.3
	5	75K	200 BFO Off
	6	75K	140 BFO On
	7	0 BFO Off 142K BFO On .6	0 BFO Off 69 BFO On 0
V115 5V4G	1	NC	NC
	2	40K	+240
	3	NC	NC
	4	620	AC 300
	5	NC	NC
	6	620	AC 300
	7	NC	NC
	8	40K	+240
V116 OA2	1	44K	+150
	2	NC	NC
	3	NC	NC
	4	Gnd	Gnd
	5	NC	NC
	6	NC	NC
	7	44K	+150