

INSTRUCTION MANUAL

R. L. DRAKE
MODEL

R-4 RECEIVER



PRICE
Instruction Manual
\$200

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GENERAL SPECIFICATIONS

FREQUENCY COVERAGE: 3.5-4.0 Mc, 7.0-7.5 Mc, 14.0-14.5, 21.0-21.5, and 28.5-29.0 Mc with crystals supplied. Ten accessory crystal sockets are provided for coverage of any 10 additional 500 KC ranges between 1.5 and 30 Mc with the exception of 5.0-6.0 Mc.

SELECTIVITY: Drake tunable passband filter provides:

- .4 KC at 6 DB down and 2.6 KC at 60 DB down
- 1.2 KC at 6 DB down and 4.8 KC at 60 DB down
- 2.4 KC at 6 DB down and 8.2 KC at 60 DB down
- 4.8 KC at 6 DB down and 20 KC at 60 DB down

Selectivity switching is independent of detector and AVC switching.

I.F. FREQUENCIES: First I.F. - 5645 KC crystal lattice filter; second I.F. 50 KC tunable L/C filter.

STABILITY: Less than 100 cycles after warm up. Less than 100 cycles for 10% line voltage change.

SENSITIVITY: Less than .5 uv for 10 DB signal plus noise to noise on all amateur bands.

MODES OF OPERATION: SSB, CW, AM, RTTY

DIAL CALIBRATION: Main dial calibrated 0 to 500 KC and 500 to 1000 KC in 5 KC divisions. Vernier dial calibrated 0 to 25 KC in 1 KC divisions.

CALIBRATION ACCURACY: Better than 1 KC when calibrated at nearest 100 KC point.

AVC: Amplified delayed AVC having slow (.75 sec.) or fast (.025 sec.) discharge; less than 100 microsecond charge. AVC can also be switched off. 3 DB change in AF output with 60 DB change in RF input.

AUDIO OUTPUT: 1.4 watts max. and .5 watts at AVC threshold.

AUDIO OUTPUT IMPEDANCE: 4 ohms and hi impedance for anti-vox.

ANTENNA INPUT: Nominal 52 ohms.

SPURIOUS RESPONSES: Image rejection more than 60 DB. I.F. rejection more than 60 DB on ham ranges. Internal spurious responses in ham ranges less than the equivalent 1 uv signal on the antenna.

TUBE COMPLEMENT:

<u>TUBE</u>	<u>FUNCTION</u>
12BZ6	RF amp.
12BA6	100 KC calibrator
6HS6	1st mixer
6AU6	PTO
6KZ8	Premixer/xtal osc.
12BE6	2nd mixer and xtal osc.
12BA6	50 KC IF
12BA6	50 KC IF
12AV6	AVC amp./AVC det.
6GX6	Prod. det./audio amp.
6EH5	Audio Output
12BA6	Noise blanker amp.
12AX7	Noise blanker pulse amp./shaper
IN625	Noise blanker gate
2-IN625	Noise blanker pulse clippers
IN625	AM detector
ED-3004	Bias rectifier
2-IN3756	Power Supply rectifiers
OB2 + IN625	Voltage Regulator

FRONT PANEL CONTROLS: Main tuning, AF gain, RF gain, SSB/CW-AM with slow AVC, fast AVC, or AVC off, function switch, band switch, xtal switch, passband tuning and selectivity, preselector, notch, and head-phone jack.

REAR AND SIDE JACKS AND CONTROLS: S-Meter zero, NB threshold, notch adjust, antenna jack, speaker jack, mute jack, anti-vox jack, accessory power socket, ground post, and fuse post.

POWER CONSUMPTION: 60 watts, 120/240 VAC, 50/60 cycles.

DIMENSIONS: 5-1/2" high, 10-3/4" wide, cabinet depth 11-5/8", overall length 12-1/4", weight 16 lbs.

I GENERAL DESCRIPTION

The DRAKE R-4 is an extremely versatile communication receiver designed to bring you every feature desirable for the ultimate in the reception of all modes of amateur communications.

It provides a linear permeability-tuned VFO with 1 KC readability, and premixed injection with crystal controlled high frequency oscillator for stability on all bands. A 100 KC crystal calibrator is built-in.

An improved passband tuner/filter with four selectivity positions, and a built-in notch filter are incorporated to provide the desired selectivity and interference rejection, and a noise blanker is built-in for elimination of most noise on CW, SSB and AM.

As supplied, the unit gives complete coverage of 80, 40, 20, and 15 meter bands as well as the 28.5 MC to 29.0 MC portion of 10 meters. Ten accessory crystal sockets are provided for coverage of other 500 KC frequency ranges between 1.5 and 30 MC such as 160 Meters, MARS frequencies, WWV, short wave broadcast, etc. These sockets can be programed to give up to 5 MC of continuous coverage for convenient use with V.H.F. converters.

The R-4 also includes time proven DRAKE AVC with fast-attack slow-release for SSB or AM and fast-attack fast-release for CW. If desired, the AVC can be completely disabled for CW reception.

Complete AVC action and accurate S-meter indication can be obtained, on all modes. A crystal-lattice filter following the first mixer provides excellent overload characteristics by providing selectivity before gain producing stages.

When used with our T-4 Reciter, transceive operation may be obtained, and when used with the T-4X transmitter, either transceive or independent receive and transmit functions are possible.

II INSTALLATION INSTRUCTIONS

A. UNPACKING

Carefully remove your R-4 from the packing carton and examine it closely for signs of shipping damage. Should any be apparent, notify the delivering carrier immediately, stating the full extent of the damage.

Fill out and mail the enclosed registration card so that your warranty will be effective.

Save the packing material. It was expensive and you may need it later for reshipment or storage.

Inspect the packing material closely before putting it away to be sure that you have not overlooked any accessory hardware.

B. LOCATION

In general the location of the R-4 is not critical. However, care should be taken to insure that space is allowed around the unit for adequate air circulation. Extremely hot locations, such as near radiators or heating units, should be avoided. Do not cover the top of the R-4 with books, papers, or pieces of equipment, as overheating may result.

C. POWER REQUIREMENTS

The R-4 is supplied with a dual-primary power transformer and can be operated from 120 or 240 volt 50/60 cycle AC. As supplied from the factory, it is wired for 120 volt operation. If 240 volt operation is desired, it will be necessary to remove the black/yellow and black/green power transformer primary wires from the terminals to which they are now connected and connect them together at the unused terminal on the same terminal strip. It will also be necessary to replace the .75 amp fuse supplied with the unit with a .4 Slo-Blo amp fuse for adequate protection at the increased voltage (see schematic diagram).

D. ANTENNA REQUIREMENTS

The R-4 is designed to give best results when used with an antenna resonant on the operating frequency and having an impedance from 50 to 75 ohms. This requirement is most easily met using a center-fed dipole antenna cut to the desired frequency and fed with RG58A/U cable. However, there are many other antennas which will fulfill this requirement. For a more detailed description on antennas, we suggest you refer to the ARRL Antenna Book or The Radio Amateur's Handbook.

Antenna connection to the R-4 is provided at the jack on the rear of the chassis marked ANT.

It is recommended that when the R-4 is used with a transmitter, the transmitting antenna be used; change-over being accomplished by an antenna relay. This function is provided internally in our model T-4 and T-4X Transmitters.

E. SPEAKER REQUIREMENTS

A good quality 4 ohm speaker should be connected to the jack on the rear of the chassis marked SPKR. If one lead of the speaker is grounded to its cabinet, its connection should be to the chassis of the R-4.

Our accessory speaker model MS-4 provides the correct match, correct tonality for good communications audio, correct connector, and is compatible in appearance with the R-4. It will also house our model AC-4 power supply which is needed in conjunction with our model T-4 and T-4X Transmitters.

F. ANTI-VOX

A high impedance output is provided at the ANTI-VOX jack on the rear of the R-4 chassis for use with our T-4 and T-4X transmitters and other transmitters having voice control capabilities. The impedance at this terminal is approximately 5000 ohms. If the transmitting equipment requires a lower impedance it may be necessary to attach a matching transformer between the ANTI-VOX terminal on the R-4 and the ANTI-VOX input terminal of the transmitter, or to use the speaker output.

G. MUTING

The Mute jack on the rear of the R-4 is connected so that when the function switch is in EXT-MUTE position the receiver will operate only when the inner-conductor of this jack is shorted to ground, and the R-4 will mute when the inner-conductor is open with respect to ground.

The inner-conductor should, therefore, be connected to a relay contact in the transmitter or antenna relay which is normally open when transmitting and grounded when receiving. It is recommended that a shielded wire be used between the mute terminal and the relay such as is provided with our model T-4 and T-4X Transmitters.

If external muting is not desired, the STBY and ON positions of the function switch can be used. It is necessary to insert a shorted plug in the Mute Jack to obtain N.B. and CAL functions. Such a plug is installed in each R-4 when shipped.

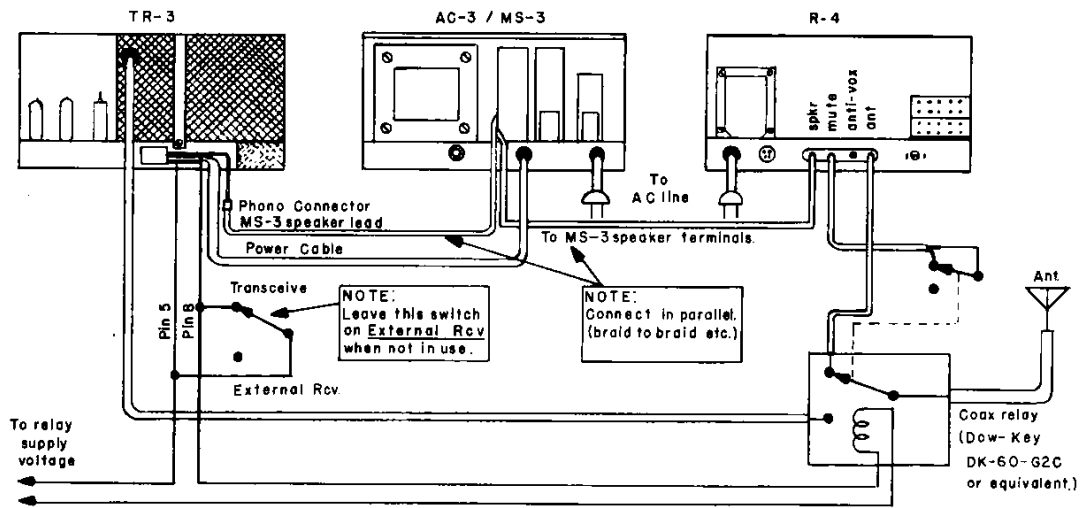


FIGURE 1 Connecting the R-4 to the TR-3 Transceiver

VIEWING ANGLE OPTIONS

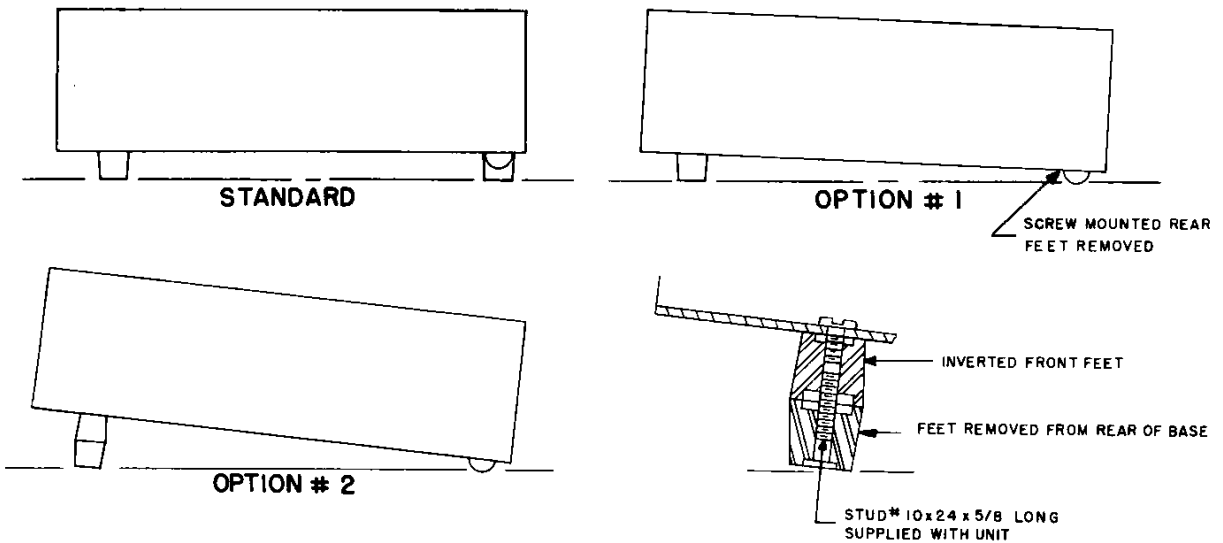


FIGURE 2

III CONTROL FUNCTIONS

A. FRONT

1. **MAIN TUNING** - The MAIN TUNING knob of the R-4 determines the frequency on which you are receiving. The vernier skirt around this knob is calibrated in KC's from 0 to 25. The main dial is calibrated in five KC divisions and has two scales. Use the 0 to .500 scale for bands 7.000-7.500, 14.000-14.500, 21.000-21.500, etc.; use the .500 to 1.000 scale for bands 1.500-2.000, 3.500-4.000, 28.500 - 29.000, etc. The small red knob just to the right of the dial scale is for adjusting the position of the indicator line for calibrating the main dial. The knob skirt is also adjustable by pushing it in slightly and rotating it in the desired direction while holding the main tuning knob stationary.
2. **BAND** - The BAND control is a six position switch used to select the amateur band desired or to switch the RF circuits to the correct tuning range when tuning accessory frequency ranges. The frequency range which may be tuned for each setting of the band switch control is given on the chart on page 16.
3. **XTAL** - The XTAL switch is an eleven position switch used to determine which crystal socket will be inserted in the circuit. When it is in the normal position, crystal selection is accomplished by means of the band switch (with the exception of the 1.5 setting). When this switch is set on any of the other positions 1 through 10, the crystal inserted in the corresponding crystal socket will be inserted in the circuit for accessory band operation. The BAND switch must then be set in accordance with the information given on the crystal frequency chart for reception of the frequency desired.
4. **PRESELECTOR** - The PRESELECTOR control permeability-tunes the antenna, RF, and pre-mixer coupling coils to the desired frequency. The logging scale on this control is calibrated from 0 to 10 with markings showing the correct settings for the 160 through 10 meter amateur bands.
5. **FUNCTION** - The FUNCTION switch is a six position switch used to select the method of operating the R-4.

When in the OFF position the power transformer primary is opened, thus turning the unit off. When in the STBY position, the power is connected, thus allowing the filament and B+ to operate but the receiver is muted regardless of external connection. When in the ON position, the receiver is unmuted regardless of external muting connection. When in the EXT-MUTE POSITION, the receiver is muted or unmuted depending upon whether or not the mute connection on the rear of the chassis is grounded, thus permitting external control

by the transmitter. When in the N.B. position the noise blanker is energized, and when in the CAL position, the noise blanker is switched off and the calibrator is switched on. In these last two positions the muting function is the same as if the switch were in the EXT-MUTE position, so if external muting is not used, a shorted plug must be inserted in the Mute jack to obtain these functions.

6. SSB/CW-AM - This switch determines the detector which is used and the AVC mode. When in the AM position, a diode detector is incorporated, the BFO is switched off, and the AVC with a slow time constant is used. The other three positions under the heading SSB/CW employ a product detector with the BFO. In the SLOW AVC position the AVC delay time is about .75 seconds. In the FAST AVC position it is approximately .025 seconds. In the AVC OFF position no AVC is generated. The SLOW AVC position should normally be used with single sideband and CW and the fast position should normally be used for break-in CW and RTTY. The AVC OFF position should be used only on CW under difficult conditions in conjunction with the RF gain control.
7. GAIN - The GAIN control is composed of two concentric controls. The bar knob controls the AF output level of the receiver. The skirt knob controls the bias applied to the AVC-controlled tubes thus reducing the RF gain of the unit.
8. NOTCH - The NOTCH control tunes a highly selective notch across the receiver's passband for the purpose of eliminating interfering carriers. When turned to the OFF position, the Notch is moved outside the receiver's passband. Rotation of this control is in the same direction from the center as PASSBAND control; i.e. If PASSBAND is set to the left side (lower sideband) then heterodynes will be removed with NOTCH set left of center.
9. PASSBAND - The PASSBAND control is composed of two parts; the passband selector lever and the passband tuning knob. The selector lever is calibrated in numbers representing the band widths in KC's at 6 DB down (.4, 1.2, 2.4, and 4.8 KC).

The length and position of the lines which make up the passband tuning calibration indicate the relative band widths and their positions with respect to each other. The pointer on the Passband tuning knob represents the relative position of the fixed 50 KC BFO with respect to the movable passbands. The dots at the ends of the lines indicate the correct settings of the PASSBAND tuning knob for single sideband reception. All of the left hand dots are for lower sideband and all of the right hand dots are for upper sideband.

For CW reception on the .4 position the signal is tuned for most pleasing note with the frequency knob and is then peaked with the PASSBAND tuning knob. You can then tune other stations without changing the PASSBAND tuning knob setting. The audio frequency at maximum signal strength will be correct.

10. PHONE JACK - A PHONE JACK is provided on the front of the R-4 for private listening when desired. The Jack automatically mutes the speaker output when headphones are plugged in. While the headphone impedance is not critical (adequate output is available for most commercially available phones) more output is obtained on lower impedance phones. We recommend a good set of 600 ohm phones, such as the Trimm type 56-06.
11. S-METER - The S-METER indicates relative signal strength of the received signal. It is calibrated in S-units from S-1 to S-9 and DB over S-9. Each S-unit equals about 5 DB and S-9 is about 30 microvolts at the ANT terminal.

B. REAR CONTROLS & JACKS

1. S-METER ZERO - The S-METER ZERO control is on the rear of the R-4 Chassis. It is for the purpose of setting the S-Meter needle to S-1 under no signal conditions.
2. SPEAKER JACK - The SPEAKER JACK on the rear of the chassis is for the connection of a 4 ohm speaker such as our MS-4.
3. MUTE JACK - The MUTE JACK is for externally muting and unmuting the receiver. The receiver is muted when the FUNCTION switch is in the EXT-MUTE, N.L., and CAL positions and when the center conductor of this jack is open from ground. Shorting the center conductor to ground returns the receiver to the receive condition.
4. ANTI-VOX JACK - High impedance audio is brought out the ANTI-VOX JACK for use in energizing the ANTI-VOX circuit of a transmitter used with the unit such as our T-4 and T-4X.
5. ANTENNA JACK - The ANTENNA JACK provides a means for connecting the R-4 to an antenna. The input impedance at this point is approximately 52 ohms and can be used with antennas having impedances between 50 and 75 ohms.
6. POWER SOCKET - A POWER SOCKET is provided on the rear of the R-4 for operating external accessories. This plug mates with a Cinch Type 5AB2 connector. Maximum load is 6.3 VAC @ .75 amp and +150 VDC @ 30 ma.

C. SIDE CONTROLS & JACKS

1. NOISE BLANKER THRESHOLD - The NOISE BLANKER THRESHOLD control determines the threshold point of the noise gate. Normally it needs to be set only when the receiver is installed. For a detailed description of proper procedure see operating instructions.
2. NOTCH ADJ - NOTCH ADJ control is a balancing device which determines the amount of attenuation obtained with the T-notch filter. This control also needs to be set very rarely. For the proper adjustment see operating instructions.
3. CRYSTAL LOCK SOCKET - The PTO in the R-4 may be locked to a particular frequency by inserting a crystal in the lock socket. For details see "Fixed Frequency Operation" in the operating instructions.

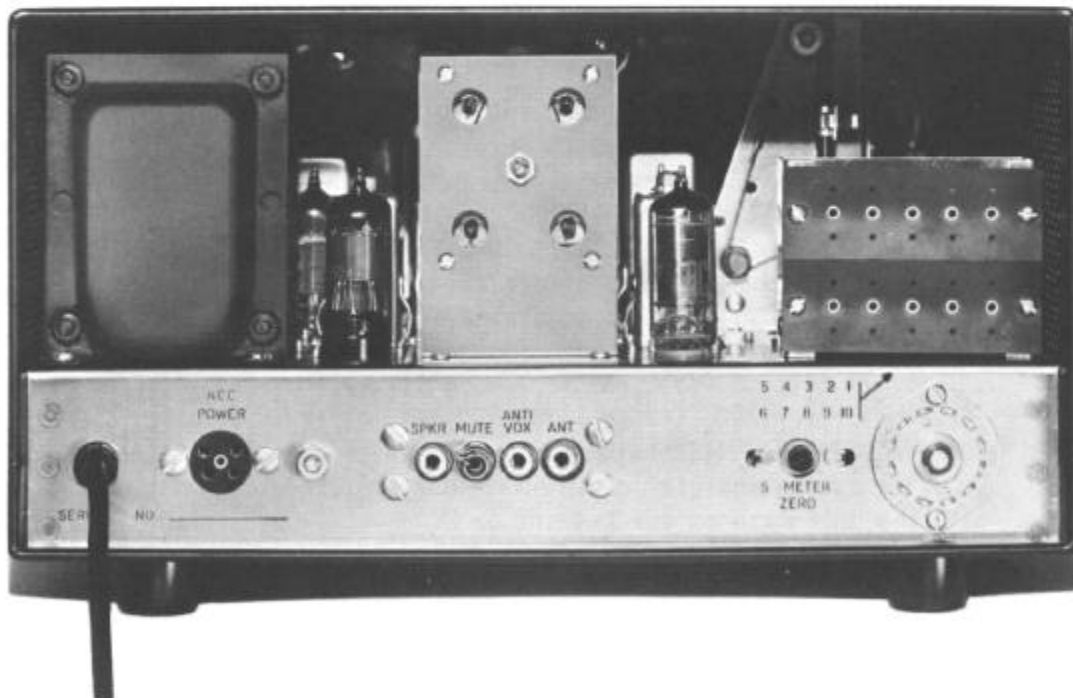


Figure #3 REAR VIEW

IV OPERATION

A. Preliminary Control Settings

For all modes of operation set these controls as follows:

FUNCTION	-- On
BAND	-- Set to desired amateur band (see "accessory frequency coverage" for information concerning coverage of other frequencies)
XTALS	-- NORM
PRESELECTOR	-- Peaked for maximum S meter reading on operating frequency
NOTCH	-- Off
R.F. Gain	-- Fully clockwise
A.F. Gain	-- Comfortable level

B. Single Sideband or Double Sideband Suppressed Carrier Reception

1. Set the Passband selector lever to 2.4 KC and set the Passband knob to the dot at the end of the third line from the top corresponding to the sideband desired.
2. Set the SSB/CW-AM switch to Slow AVC.
3. Tune in a station with the main tuning for pleasing audio characteristics.

If noise is a problem, switch the Function switch to N.B. (see function switch and noise limiter explanation).

If interference from undesired stations is a problem, adjust the PASSBAND selector lever to the 1.2 KC position and readjust the PASSBAND knob to the dot at the second line from the top corresponding to the desired sideband.

A heterodyne from a nearby carrier can be eliminated with the Notch control. A more detailed description of the use of this control follows under "Operation of Notch Control."

C. C .W. Reception

1. Set the Passband selector lever to 1.2 KC and set the Passband knob to either of the dots at the ends of the second line from the top.
2. Set the SSB/CW-AM switch to Slow AVC.
3. Tune in a station for pleasing audio pitch with the main tuning knob and readjust the Passband knob for maximum S-meter reading.

Under crowded band conditions it will be advantageous to use the .4 KC selectivity position and reposition the Passband knob for maximum S-Meter reading on a signal tuned in to the desired pitch. After the Passband control is adjusted thusly, simply tune in a CW signal for maximum S-Meter reading and it will automatically be the correct pitch.

It will sometimes be to your advantage to shift the passband of the receiver to the other side of the BFO frequency for better copy under crowded band conditions. This can be accomplished simply by repositioning the Passband knob to the alternate dot and retuning the station with the main tuning knob.

Noise and strong interfering signals can be attenuated using the N.B. and Notch functions as described later in this section.

Many operators prefer no AVC on CW. If this is your preference, turn the SSB/CW-AM switch to the AVC OFF position, turn the A.F. Gain fully clockwise and regulate receiver gain with the R.F. Gain control.

D. AM Reception

1. Set the Passband selector lever to 4.8 KC and set the Passband tuning knob to the middle of the longest line.
2. Set the SSB/CW-AM switch to AM.
3. Tune in a signal with the main tuning knob.

Interfering heterodynes can now be eliminated using the Notch control, and noise can be reduced or eliminated by turning the Function switch to N.B. A detailed description of these functions follows.

E. RTTY Reception

1. Set the Passband selector lever to the 1.2 KC position and set the Passband knob to the right of the dot corresponding to upper sideband.
2. Set the SSB/CW-AM switch to Fast AVC.
3. Tune in a signal with the main tuning knob for correct indication on your terminal unit tuning indicator and adjust Passband tuning knob for equal S-Meter reading of both mark and space.

If the station you are copying is sending upside down (mark low-space high) turn the passband control to the left of the "lower" dot and re-tune the station with the main tuning dial.

If noise is a problem, turn the Function switch to N.B. Interfering heterodynes can be eliminated using the Notch control.

F. Adjusting Dial Calibration

The calibration of the main tuning dial on the R-4 may vary slightly from band to band due to the tolerance limits of the various crystals. Therefore, the main tuning dial index has been made adjustable by means of the small red knob to its right. To set the calibration on a given band, proceed as follows:

1. Set Band Switch, Preselector, and Xtal switch to the desired band.
2. Set Function switch to CAL.
3. Set SSB/CW-AM switch to Slow AVC.
4. Tune in 100 KC crystal calibrator signal for zero beat at the 100 KC point nearest the desired operating frequency.
5. Slide the red knob at the right of the dial scale until the index line coincides with the 100 KC dial calibration.
6. While holding the main tuning knob, push in on its calibrated skirt and turn until the "o" mark coincides with the indicator line.

G. Noise Blanker Operation

The noise blanker in the R-4 is an I.F. device which turns off the receiver during a noise pulse. It is equally effective on all modes of operation and greatly attenuates most impulse noise. Before optimum results can be expected, however, the Noise Blanker Threshold control, located on the side of the R-4 chassis should be adjusted as described here.

1. With the antenna connected, tune in a strong SSB signal which is free of noise. (Follow procedure given in paragraph 13, page 12.)
2. Turn Function switch to N.B. and advance the N.B. Threshold control until distortion of the signal is noted.
3. Turn the control slightly counter clockwise until no further distortion is observed.

The noise blanker is now ready for operation. For normal operation under "no noise" conditions, the Function switch should be positioned in other than the N.B. setting. However, if noise becomes a problem, simply switch to N.B. It will be noticed that the noise blanker functions only when needed; that is when the noise is greater than the desired signal. Due to the effect of AVC in giving constant AF output, the noise may not appear to decrease. However, signals down in the noise will come up and can be copied which were undetectable previously.

It will also be noted that the N.B. works best on noise pulses which are very short in duration and which are separated widely in time, (i.e. automobile ignition noise). The closer the pulses are together, the less effective the N.B. will be since the noise detector circuitry has more and more difficulty distinguishing the noise from the desired signal.

H. Operation of NOTCH control

The notch control on the R-4 consists of a permeability-tuned T-notch filter in the 50 KC I.F. This filter is capable of producing a deep notch which can be tuned across the receiver's I.F. for the elimination of interfering carriers in all modes of operation.

In order to obtain optimum results using this control, it is first necessary to set the "notch adjust" control located on the side of the chassis as described here.

1. Preset R-4 controls as follows:

FUNCTION	-- Cal
PASSBAND	-- Selector 2.4 or 4.8, Knob upper or lower
BAND	-- 3.5 Mc
XTALS	-- NORM
R.F. GAIN	-- Fully clockwise
A.F. GAIN	-- Comfortable level
SSB/CW-AM	-- Fast AVC
NOTCH	-- Off

2. With the main tuning knob, tune in the crystal calibrator for low pitched audio note and peak the preselector for maximum S-Meter reading.
3. Advance the Notch control counter clockwise until some reduction in S-meter reading is observed.
4. Adjust Notch Adjust (located on right side of chassis) for further attenuation.
5. Alternately adjust Notch and Notch Adjust for minimum S-meter reading. This is the optimum setting for notching and further adjustment should rarely be necessary.

In order to eliminate an unwanted carrier on any mode of operation, simply tune the Notch control across the Passband of the receiver until the carrier drops into the notch and is thus eliminated. Note that it is just as easy to notch out the desired carrier so a little practice will be necessary to enable the operator to use the control most effectively.

Rotation of the Notch control is in the same direction from center as Passband control. That is, if Passband is set to the left side (lower sideband) then heterodynes will be removed with the Notch control set to left of center.

I. Accessory Frequency Coverage

In addition to reception on 80, 40, 20, 15, and the 28.5-29.0 portion of 10 meters, the R-4 can be programed to receive any ten 500 KC-wide ranges between 1.5 and 30.0 Mc (excluding 5.0 to 6.0 Mc) by inserting the appropriate crystal in one of the ten accessory crystal sockets. These sockets face out the rear of the unit on the left side of the chassis.

In order to determine the correct crystal frequency, simply add 11.1 to the lowest frequency of the 500 KC range to be covered. For example; assume you wanted to receive 1.5 to 2.0 Mc for reception of the 160 meter amateur band. The crystal frequency would be the lowest frequency of the desired range (1.5 Mc) plus 11.1 which would equal 12.6 Mc. This crystal can then be inserted in any one of the ten accessory crystal sockets provided.

IMPORTANT: Only parallel resonant crystals designed for a Miller oscillator should be used.

In order for the desired band to be received the XTAL switch must be turned to the number corresponding to the crystal socket in which the crystal in question is inserted. The lowest frequency of the range made available may then be written in the range window with pencil for future reference.

If crystals are changed you may erase the previously inscribed numbers easily.

The BAND switch must now be turned to a position which will allow the PRESELECTOR to tune the desired range. Recommended ranges are as follows:

<u>BAND</u>	<u>PRESELECTOR TUNING RANGE (MC)</u>
1.5-3.0	1.5 - 3.0
3.5	3.0 - 5.0
7.0	6.0 -10.0
14.0	10.0 -16.0
21.0	16.0 -23.0
28.5	23.0 -30.0

In our example, the BAND switch should be placed in the 1.5 position and the preselector should be peaked on the 160 meter portion of its scale.

A chart showing the preselector frequency vs. log scale setting for each Band switch position is shown on page 18.

The table on page 17 shows the correct crystal frequency, and Band setting for ranges between 1.5 and 30 mc (excluding 5.0-6.0 mc).

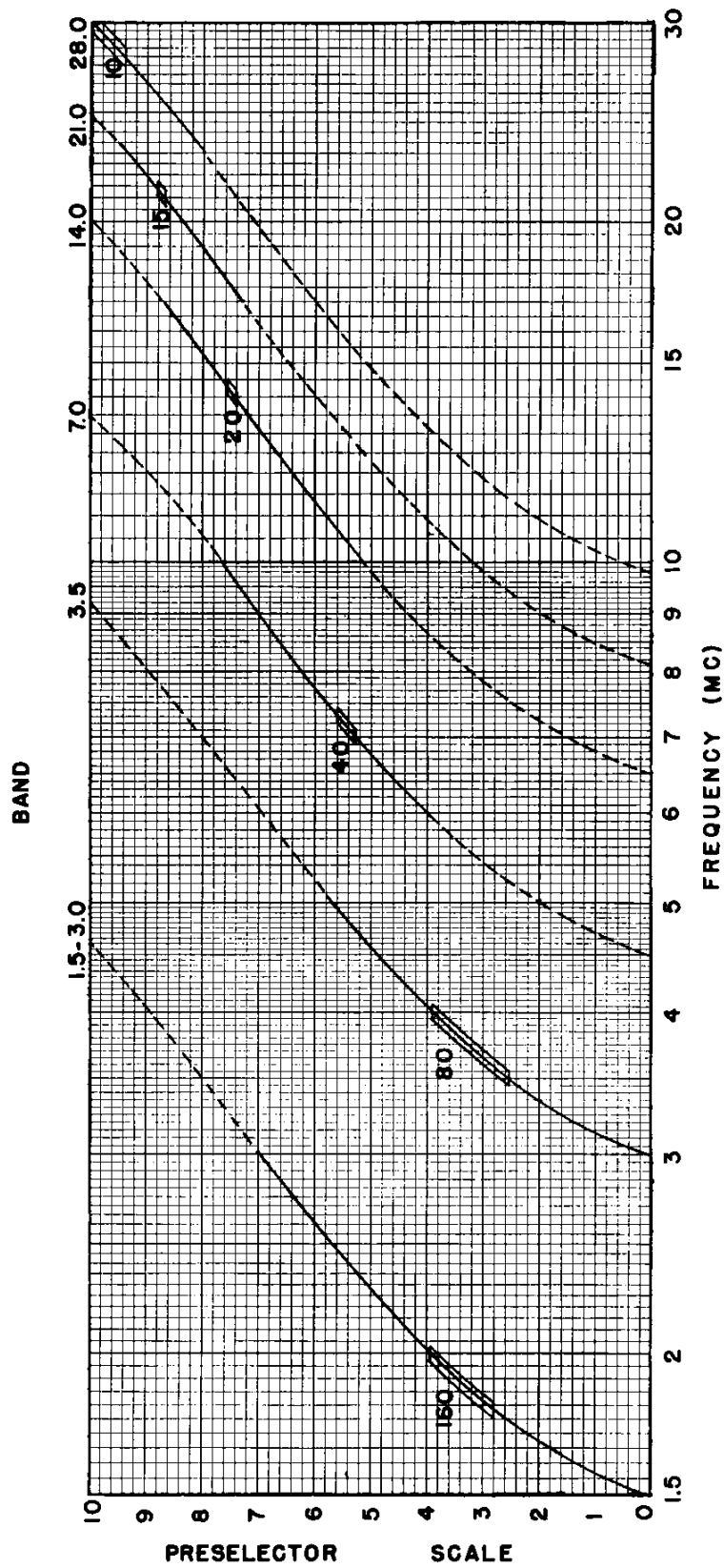
When receiving ranges starting with an even megacycle, the 0.000 to .500 range on the main tuning dial may be used and when receiving ranges starting with a half megacycle, use the .500 to 1.000 mc scale.

Figure #4 CRYSTAL FREQUENCY CHART

<u>FREQ. RANGE</u>	<u>CRYSTAL</u>	<u>BAND</u>	<u>FREQ. RANGE</u>	<u>CRYSTAL</u>	<u>BAND</u>
1.5 - 2.0	12.6*	1.5 - 3.0	16.5 - 17.0	27.6	21.0
2.0 - 2.5	13.1	1.5 - 3.0	17.0 - 17.5	28.1	21.0
2.5 - 3.0	13.6	1.5 - 3.0	17.5 - 18.0	28.6	21.0
3.0 - 3.5	14.1	3.5	18.0 - 18.5	29.1	21.0
3.5 - 4.0	14.6*	3.5	18.5 - 19.0	29.6	21.0
4.0 - 4.5	15.1	3.5	19.0 - 19.5	30.1	21.0
4.5 - 5.0	15.6	3.5	19.5 - 20.0	30.6	21.0
6.0 - 6.5	17.1	7.0	20.0 - 20.5	31.1	21.0
6.5 - 7.0	17.6	7.0	20.5 - 21.0	31.6	21.0
7.0 - 7.5	18.1*	7.0	21.0 - 21.5	32.1*	21.0
7.5 - 8.0	18.6	7.0	21.5 - 22.0	32.6	21.0
8.0 - 8.5	19.1	7.0	22.0 - 22.5	33.1	21.0
8.5 - 9.0	19.6	7.0	22.5 - 23.0	33.6	21.0
9.0 - 9.5	20.1	7.0	23.0 - 23.5	34.1	28.5
9.5 - 10.0	20.6	7.0	23.5 - 24.0	34.6	28.5
10.0 - 10.5	21.1	14.0	24.0 - 24.5	35.1	28.5
10.5 - 11.0	21.6	14.0	24.5 - 25.0	35.6	28.5
11.0 - 11.5	22.1	14.0	25.0 - 25.5	36.1	28.5
11.5 - 12.0	22.6	14.0	25.5 - 26.0	36.6	28.5
12.0 - 12.5	23.1	14.0	26.0 - 26.5	37.1	28.5
12.5 - 13.0	23.6	14.0	26.5 - 27.0	37.6	28.5
13.0 - 13.5	24.1	14.0	27.0 - 27.5	38.1	28.5
13.5 - 14.0	24.6	14.0	27.5 - 28.0	38.6	28.5
14.0 - 14.5	25.1	14.0	28.0 - 28.5	39.1*	28.5
14.5 - 15.0	25.6	14.0	28.5 - 29.0	39.6*	28.5
15.0 - 15.5	26.1	14.0	29.0 - 29.5	40.1	28.5
15.5 - 16.0	26.6	14.0	29.5 - 30.0	40.6	28.5
16.0 - 16.5	27.1	21.0			

* Supplied with receiver

* Supplied with receiver



NOTE: SOLID LINE INDICATES RECOMMENDED RANGE FOR EACH BAND.

Figure #5 PRESECTOR CHART

J. Fixed Frequency Operation

The PTO in the R-4 can be locked by plugging a 5.455 mc crystal in the crystal socket on the side of the TR-3 chassis.

This allows the R-4 to be programed to operate on one or more fixed frequencies by inserting crystals in the accessory crystal socket located at the rear of the unit.

In order to determine the correct crystal frequency to use for a particular operating frequency, apply the following formula:

$$\text{Crystal frequency (Mc)} = \text{Operating frequency (Mc)} + 11.1$$

The PRESELECTOR and BAND switch should be positioned as described under "Accessory frequency coverage" for the desired frequency, and the Main Tuning dial should be set at .800 for accurate operation. Tuning the Main Tuning dial up to 1.000 and down to .700 will allow the 5.455 Mc crystal to be pulled about ± 300 cycles for the tuning. The VFO dial should not be tuned below .650, however, or the crystal will not operate reliably.

Example: Assume that you desire to operate on a net frequency at 3.950 Mc. The following steps should be followed:

1. Determine the frequency of the high frequency oscillator crystal from the formula:
Crystal frequency (Mc) = operating frequency (3.95 Mc) + 11.1.
Crystal frequency = 15.050 Mc.
2. Insert the 15.050 Mc crystal in an unused accessory crystal socket and turn the XTAL switch to the position corresponding to this socket.
3. Insert a 5.455 Mc Crystal in the crystal lock socket and set the main tuning dial to .800.
4. Set the BAND switch to 3.5 and peak the PRESELECTOR to the 80 meter portion of its scale.

You should now be on the desired frequency. If a slight error is noted, it can be eliminated by fine tuning with the main tuning dial.

The 5.455 Mc crystals for the crystal lock sockets are supplied by us and may be obtained either direct or through your dealer.

Crystals for the high frequency oscillator are of the parallel resonant type and should have a calibration tolerance of .001% to insure sufficient vernier tuning on highest frequencies. When ordering please specify whether or not crystal is to be used for fixed frequency operation.

V THEORY OF OPERATION

A. R.F. Amplifier

A signal entering the antenna is applied to the grid of the low noise 12BZ6 R.F. amplifier tube (V1) through the tuned circuit formed by the coil T1 and capacitors C21 through C31.

Here it is amplified and the output is tuned by the circuit formed by coil T2 and capacitors C1 through C11. The signal is then applied to the grid of the 6HS6 first mixer (V2).

B. First Mixer and Premixer System

A signal from the pre-mixer system is applied to the cathode of the 6HS6 first mixer tube (V2), 5645 KC above the incoming signal frequency applied to its control grid. This results in 5645 KC I.F. output.

The pre-mixer system consists of a 4955 KC to 5455 KC permeability tuned VFO (V11), a switchable overtone crystal oscillator (V8B), the pre-mixer (V8A), and the pre-mixer output circuitry composed of T3 and T4 and their tuning and coupling capacitors.

The VFO signal is applied to the cathode of the pre-mixer V8A (pentode section of 6KZ8) through the bandpass coupling transformer T12, and output from the crystal oscillator V-8B (triode section of 6KZ8) is applied to the grid.

The crystal frequencies are selected so that the difference frequency output of the pre-mixer is 5645 KC above the frequency of the desired incoming signal.

For example, on 80 meters a 14.6 mc crystal is used in the crystal oscillator. This frequency and the 4955 - 5455 KC VFO output combine in the pre-mixer stage to give output from 9145 KC to 9645 KC. This signal is applied to the first mixer cathode through coils T3 and T4 and their associated tuning and coupling capacitors to beat with the incoming 3.5-4.0 Mc signal. This results in 5645 KC output.

Note that the RF coils T1 and T2 and pre-mixer output coils T3 and T4 are permeability tuned, and are ganged together. They are tuned by means of the PRESELECTOR control.

C. Second Converter

The 5645 KC output of V2 is applied to the grid of the 12BE6 second converter (V3) through a crystal filter. This gives excellent cross modulation and overload characteristics by providing selectivity before the gain producing stages.

The cathode, control grid and screen grid are connected in a Pierce oscillator configuration controlled by a 5595 KC crystal. The 5645 KC IF signal is applied to the signal grid of this tube where it beats with the crystal oscillator signal to produce 50 KC output.

D. 50 KC I.F. System

The 50 KC output of the second converter V3 is applied to the grid of the 12BA6 IF amplifier tube V4 through the T-Notch Filter composed of T8 and its associated circuitry.

Output of V4 is applied to the grid of the last 12BA6 IF amplifier (V-5) through the passband tuner T9.

The passband tuner consists of four LC circuits with high Q.

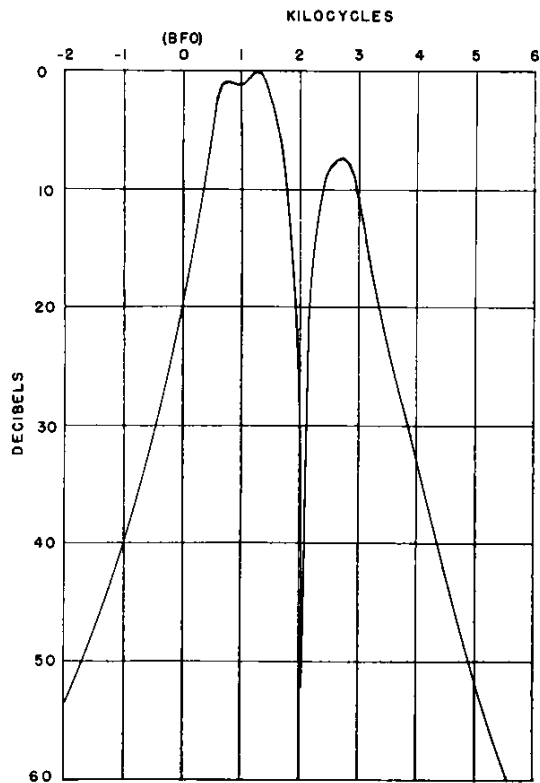
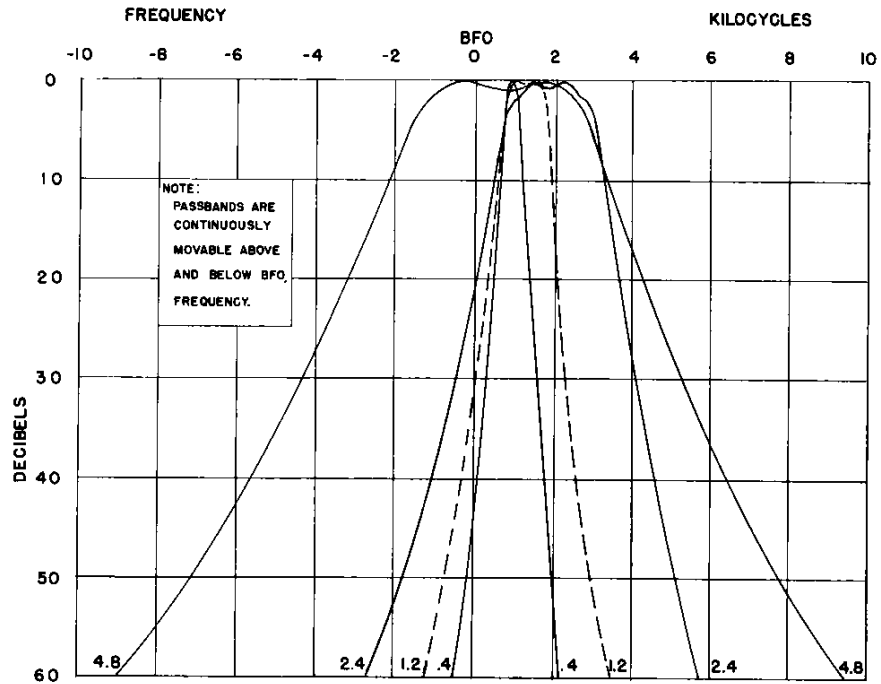
Passband tuning is accomplished by ganged permeability tuning of the four coils, and variable selectivity is accomplished by changing the coupling between the four tuned circuits.

E. Detector Systems

The amplified signal from V5 is applied to the AM detector composed of diode D7 and its associated circuitry, to the AVC amplifier V13, and to the switch S2 rear.

When the SSB/CW-AM switch is in the SSB/CW positions the output of V5 feeds into grid #3 of the 6GX6 product detector tube (V6). The cathode, grid #1, and grid #2 of this tube are connected in a Hartley oscillator circuit which operates at 50 KC. The 50 KC IF signal beats against this 50 KC oscillator to produce audio output.

When the SSB/CW-AM switch is in the AM position, the 50 KC oscillator is disabled and the output of the AM detector circuit is connected to the #3 grid of V6 which now serves as an audio amplifier.



F. Audio Output

Audio voltage from V6 is applied to the grid of the 6EH5 audio output tube V-7 through the AF gain control R39B.

The audio output from this tube is then applied to the speaker or phones through audio output transformer T16. The ANTI-VOX jack is connected directly to the plate of V7 through C122.

G. AVC System

The 12AV6 AVC amplifier (V13) is biased past cut-off to provide AVC delay. When sufficient R.F. voltage from V5 is applied to its grid, plate current flows during part of the cycle. This causes amplified negative voltage to appear across its plate load resistor R83 thus charging C108 when the SSB/CW-AM switch is in the fast AVC position and both C108 and C109 when the switch is in the slow AVC position.

The capacitor or capacitors then discharge through R83 to provide a time constant of about .75 seconds on slow AVC and about .025 seconds on fast AVC. When the switch is in the AVC off position the load resistor R83 is shorted, thus preventing AVC voltage from being developed.

AVC voltage is applied to the grid of V1, V4, V5, and Noise Blanking IF amplifier V9.

Rotating the RF Gain control counter clockwise applies increasingly more negative bias to the AVC controlled tubes thus limiting their gain.

Adjustment of the receiver sensitivity control (R87) varies the minimum bias on the AVC controlled tubes under no signal conditions with RF Gain control at maximum.

When the mute line is opened from ground, the bias voltage rises to -60 volts, thus cutting off the AVC controlled tubes.

H. S-Meter

The S-Meter operates in a bridge circuit with the plates of V-4 and V-5 on one leg and V2 and V3 on the other leg.

When AVC voltage is applied to the grids of V-4 and V-5, the tubes draw less current, thus unbalancing the bridge and causing the S-Meter to read up scale.

Adjustment of S-Meter zero pot (R42) allows the bridge balance to be varied for zeroing the meter. Zero adjustment holds under varying line voltage conditions due to current characteristics of V-2 and V-3.

The S-Meter sensitivity control R-40 varies the sensitivity of the meter for calibration purposes by varying the resistance in series with it.

I. Noise Blanker

The noise blanker in the R-4 attenuates a received noise pulse by shunting to ground the output of V-4 during the time interval of the pulse. In other words, the receiver is turned off during the pulse.

The 50 KC I.F. output of the second converter V3 is fed into the grid of the 12BA6 Noise Blanker IF amplifier V9.

Here it is amplified to a level sufficient to operate the pulse detector and separation circuit composed of D1 and D2 and their associated circuitry. This circuit operates in such a way that when a noise pulse is received of a level higher than the received signal, a negative pulse is presented to the grid of the noise shaper V10A. This stage is normally conducting and a negative pulse causes a large positive pulse to appear at the plate.

This pulse is applied to the grid of the pulse amplifier V10B.

The NB Threshold control R66 and the 100 K resistor R65 form a voltage divider which applies positive cathode bias to V10B and diode D3 preventing both from conducting.

When a positive pulse is applied to the grid of V10B, the bias is overcome causing both V10B and D3 to conduct. When D3 conducts, it shunts to ground the output of V4 through C104 and C105.

J. Crystal Calibrator

The cathode, grid #1, and grid #2, of the 12BA6 crystal calibrator (V12) are connected in a Pierce oscillator circuit which operates at 100 KC.

The operating point of the plate of this tube is such that it is quite rich in harmonics. This harmonic output is coupled to the antenna jack through capacitor C118.

The cathode is disconnected from ground in all but the CAL position of the FUNCTION switch, thus disabling the stage.

K. Power Supply

The full wave power supply uses two IN3756 diodes. Condenser input is used with +140 and +160 volts output.

The negative bias supply uses an ED-3004 diode to provide -60 volts to the AVC system for minimum bias, muting, and control of RF Gain.

An OB2 voltage regulator (V14) is incorporated to provide 108 volts regulated for operation of the VFO, Xtal calibrator, and H.F. oscillator.

The power transformer has a dual primary. As supplied, it is connected in parallel for 120 volt operation. To operate at 240 volts, it will be necessary to remove the GRN/BLACK and YEL/BLACK wires from their present terminals and connect them together at the remaining terminal of the terminal strip. This places the windings in series.

It will also be necessary to remove the .75 amp fuse and replace it with a .4 amp slo-blo fuse.

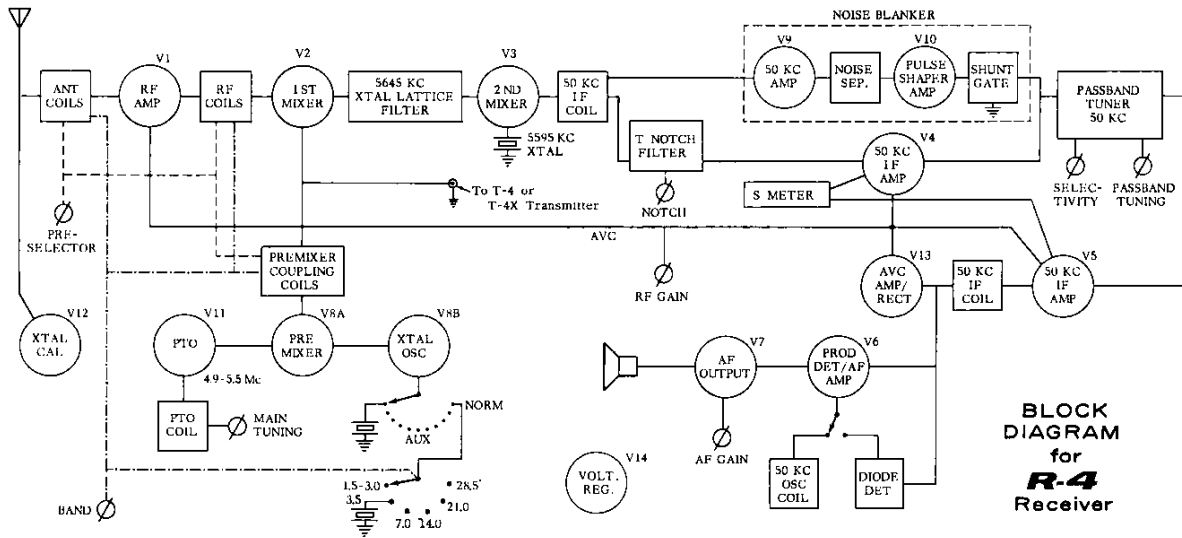


Figure #8

VI SERVICE DATA

We will check and factory align your R4 for a nominal fee of \$10.00, plus transportation charges if the set has not been tampered with. If repairs are necessary, an additional charge will be made. Units that have been tampered with or misaligned, will be repaired on a time and material basis only.

A. Removing Top Cover

1. Remove the three top screws on each side of the R-4
2. Remove cover by first pulling up on the rear and then on the front of the cabinet.

B. Removing Bottom Cover

1. Remove the six bottom screws from the sides of the R-4
2. Lift R-4 chassis out of bottom cover.

C. Tube Replacement

In general, most trouble encountered in radio equipment of good design is due to tube failure. The R-4 has been designed so that tube replacement can be done without need for realignment. The best method of finding defective tubes is direct substitution. It is best not to rely too heavily on a tube checker.

D. Troubleshooting

Careful consideration has been given in the design of the R-4 to keep maintenance problems to a minimum. However, it is quite possible that some problem will arise which cannot be cured by tube substitution. If this occurs, we suggest that you either return the unit to your dealer, or write direct to our Service Department, describing your problem in detail. Include full information concerning external connections, control settings, tubes substituted, etc.

DO NOT RETURN EQUIPMENT TO THE FACTORY WITHOUT PRIOR AUTHORIZATION.

The voltage and resistance charts which follow should be valuable in isolating minor problems. However, no attempt should be made to service the R-4 unless you are thoroughly familiar with electronic circuitry and servicing technique.

CARE SHOULD BE TAKEN NOT TO DISTURB THE LEAD DRESS IN THE R-4 SINCE SEVERAL CIRCUITS ARE QUITE CRITICAL IN THIS REGARD!

Figure #9 VOLTAGE CHART

Number	Type	1	2	3	4	5	6	7	8	9
V1	12BA6	-1.1	1.66	0	12.6*	140	129	0		
V2	6HS6	0	0	6.3*	12.6*	140	80	2.45		
V3	12BE6	-11.5	2.7	12.6*	0	140	132	0		
V4	12BA6	-1.1	0	0	12.6*	136	93	1.75		
V5	12BA6	-1.2	0	12.6*	0	110	80	0		
V6	6GX6	-3.5	1.7	0	6.3*	40	140	0		
V7	6EH5	3.4	0	12.6*	6.3*	0	91			
V8	6KZ8	107	-.14	3.0	6.3*	0	145	130	0	-5
V9	12BA6	-1.29	0	12.6*	0	128	110	0		
V10	12AX7A	65	-.38	0	0	12.6*	148	0	3.2	N.C.
V11	6AU6	-3.8	0	0	6.3*	94	100	0		
V12	12BA6	-28	0	0	12.6*	44	45	.7		
V13	12AV6	-49	-45	12.6*	0	N.C.	N.C.	1.24		
V14	OB2	108	N.C.	N.C.	N.C.	N.C.	N.C.	.67		

Notes:

1. * Indicates AC voltage.
2. Function switch is in NB position except for V12 measurements where CAL position is used.
3. R.F. and A.F. gain controls are fully clockwise. Side and rear controls are set for normal operation. SSB/CW-AM switch is in Slow-AVC position.
4. Band switch is on 3.5 and Preselector is peaked on 80 meter noise with ant. disconnected. Xtal switch is on NORM.
5. Position of other controls is unimportant.

Figure #10 RESISTANCE CHART

Number	Type	1	2	3	4	5	6	7	8	9
V1	12BA6	4.4M	150	0	F11	8.5K	7.7K	0		
V2	6HS6	2.2M	0	F11	F11	8.5K	228K	2.2K		
V3	12BE6	150K	330	F11	0	8.5K	8.5K	1.8K		
V4	12BA6	4.2M	0	0	F11	8.5K	9.5K	330		
V5	12BA6	3.7M	0	F11	0	11.7K	13.0K	0		
V6	6GX6	330K	330	F11	F11	107K	8.5K	2.5K		
V7	6EH5	100	500K	F11	F11	500K	16.1K	7.2K		
V8	6KZ8	10K	2.2M	470	F11	○	7.3K	17.3K	0	330K
V9	12BA6	2.6M	0	F11	0	8.5K	8.3K	0		
V10	12AX7A	158K	700K	0	0	F11	7K	3.2M	20K*	F11
V11	6AU6	150K	0	0	F11	15.5K	15.5K	0		
V12	12BA6	1M	0	0	F11	390K	125K	1K		
V13	12AV6	180K	70K	F11	0	INF	INF	2.2M		
V14	OB2	10K	9	INF	9	10K	INF	9*		

Notes:

1. * This resistance will vary greatly on various Ohm meter ranges due to the characteristics of diode D3.
2. Function switch is in NB position for all but V12 where CAL position is used.
3. SSB/CW-AM switch is on slow-AVC, and AF and RF Gain controls are fully clockwise.
4. All side and rear controls are in their normal operating positions.
5. The position of all other controls is unimportant.

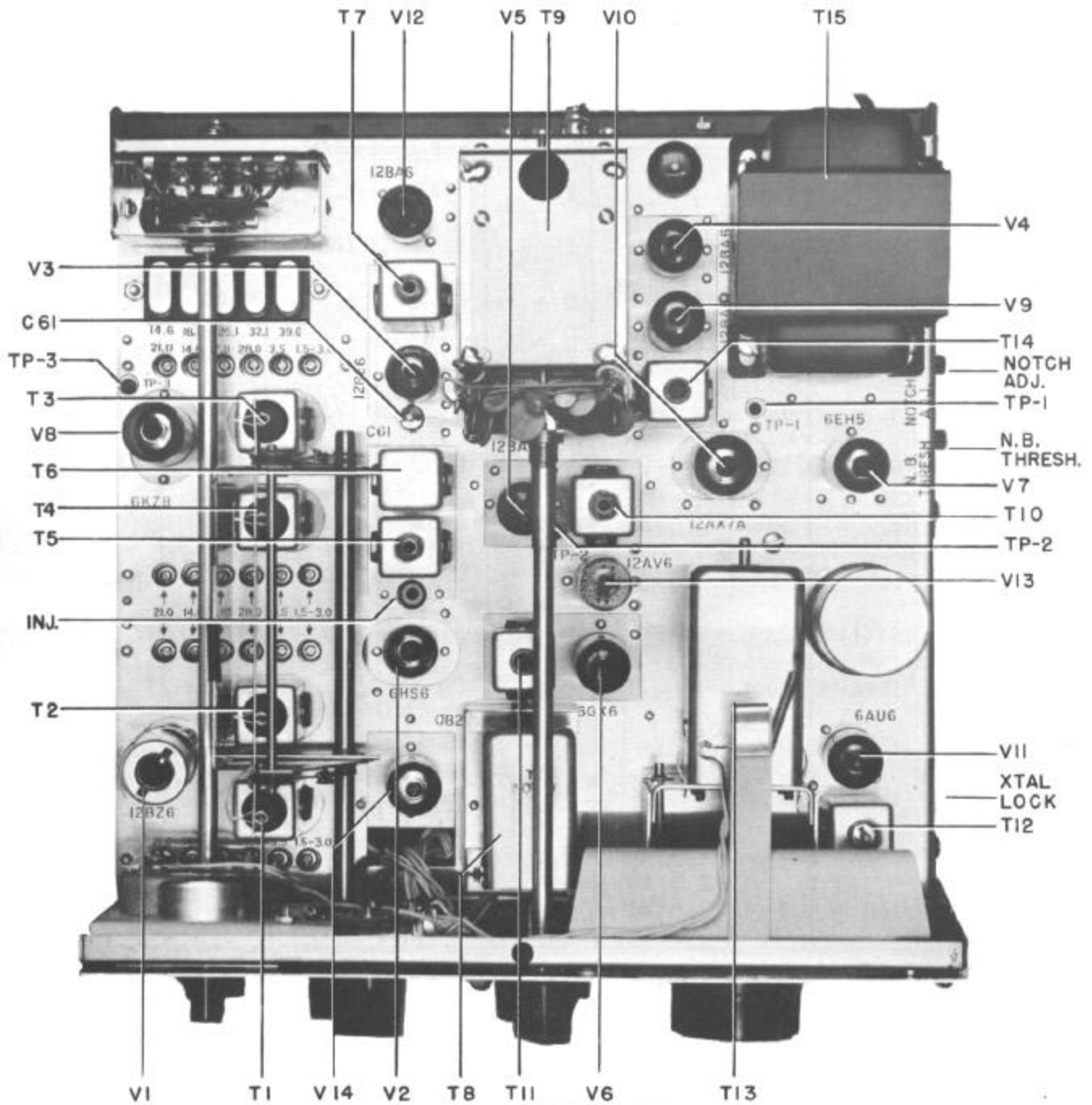


FIGURE II TOP VIEW

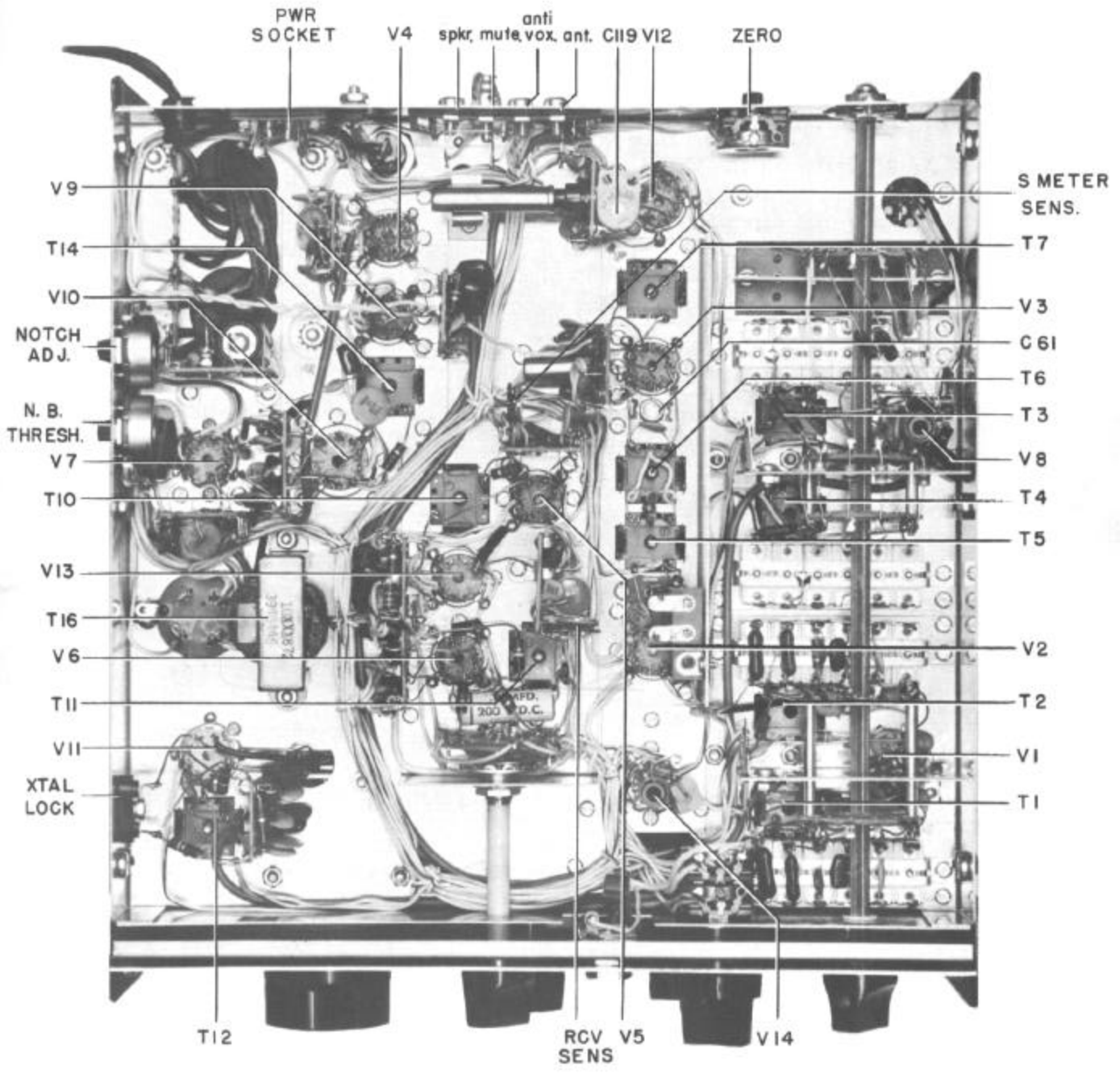


FIGURE 12 BOTTOM VIEW

VII ALIGNMENT INSTRUCTIONS

Alignment of the R-4 will require the following equipment.

1. A reasonably stable signal generator having a frequency range from 1.5 to 30.0 mc and variable output level.
2. An 11 megohm vacuum tube volt meter (VTVM)
3. An RF probe for the VTVM.
4. A 13.6 mc parallel resonant crystal designed to operate into circuit capacity of 32 pf.
5. An alignment load consisting of a .005 mfd disk ceramic capacitor in series with a 1000 ohm 1/2 watt composition resistor. Small alligator clips connected to each end would be a great help.
6. Two 10K 1/2 watt resistors

Before alignment is attempted, the R-4 should be turned on and allowed to operate for at least one half hour.

A. 50 KC Oscillator Alignment

1. Set the SSB/CW-AM switch to fast AVC.
2. Set Function switch to CAL.
3. Connect a 6" lead to your alignment load and connect it from pin 7 of the 6GX6 (V6) to pin 5 of the crystal calibrator (V12).
4. Advance A.F. gain control so that an audio beat note can easily be heard.
5. Adjust T11 for zero beat.
Note: Do not be concerned that 100 KC calibrator has not yet been set. It cannot be "pulled" far enough off frequency to be of any consequence for this purpose.
6. Remove alignment load.

B. 50 KC I.F. Alignment

1. Set the Passband selector lever to 4.8 KC and set the Passband tuning knob to the middle of the longest line.
2. Attach the signal generator to pin 7 of V3 and adjust the frequency to approximately 5645 KC. As 5645 KC is approached you should hear a loud beat note in the speaker. The generator frequency should be adjusted for zero beat.
3. Adjust the generator output for an S meter reading of approximately S-9.
4. Adjust T7 and T10 for maximum S meter reading.
5. Attach a VTVM to TP-1.
6. Adjust T14 for maximum positive voltage on VTVM (Do not remove VTVM from TP-1 yet).

C. Crystal Filter and Filter Match Transformer Alignment

1. Attach signal generator to pin #1 of V2 and set generator frequency to 5645 KC.
2. Set level so that an S-Meter reading of approximately S-9 is obtained.
3. Set Passband selector switch to 2.4 KC and set Passband knob until it points horizontally to the left.
4. Adjust signal generator frequency for peak S-Meter reading. A high pitched audio tone should be audible from the speaker.
5. Adjust generator frequency so that the tone increases in pitch. You will notice that the S-Meter reading will start to drop. Continue shifting the generator frequency until the S- Meter reading drops 20 DB. (If the meter reads S-9 at peak, it should now read S-5).
6. Adjust T5 and T6 for maximum S-Meter reading.
7. Return Passband selector lever to 4.8 and return Passband knob to center of longest line.
8. Set generator frequency to image frequency at 5545 KC and adjust generator output level until a signal is heard from the speaker.
9. Note the wires wrapped around pins on the base of the crystal filter can (T6). Unwrap one of these wires until minimum signal strength is obtained. (Note: Unwrapping the wrong wire will result in an increase rather than a decrease in this signal). If much adjustment is necessary here, steps 1 through 6 should be repeated.

D. 5595 KC Oscillator Alignment

1. Return Passband selector lever to 4.8 KC and Passband tuning knob to the center of the longest line.
2. With signal generator still attached to pin 1 of V2, and VTVM still attached to TP-1, adjust the generator frequency for maximum positive voltage. This frequency should be very near 5645 KC.
3. Observe this peak voltage and tune the generator in either direction from the point until the voltage drops 50%. Observe the generator frequency reading at this point.
4. Now tune the generator in the opposite direction until the voltage is once again 50% of peak and observe the frequency.
5. Set the generator exactly half way between these two points and adjust C61 for zero beat from the speaker.
6. Disconnect generator and VTVM.

E. Antenna, RF, and Injection Circuit Alignment

1. Turn off receiver and temporarily connect a 10K resistor across T3 and across T4.
2. Set these controls as follows:

BAND	-- 3.5
MAIN TUNING	-- 1.000
FUNCTION	-- CAL (Shorting plug installed in mute socket)
XTAL	-- Position #1
SSB/CW-AM	-- Fast AVC
NOTCH	-- Off
R.F. GAIN	-- Fully clockwise
A.F. GAIN	-- Comfortable level
PASSBAND	-- Lever - 4.8
	-- Knob - center of longest line

3. Install a 13.6 mc Crystal in accessory crystal socket #1 and set Preselector to 0. An audio tone should be audible from the speaker. If it is not, retune the main tuning slightly.
4. Peak all four trimmer capacitors marked 3.5 on R-4 chassis for maximum S meter reading
5. Switch Xtal switch to NORM and set Preselector to 3.9 on its logging scale.
6. Adjust T1, T2, T3, and T4, for maximum S meter reading.
7. Repeat steps 2, 3, 4, and 5 until no further improvement can be made.
8. Set Band switch to 28.5, set Xtal switch to NORM, and set Preselector to center of 10 meter calibration.
9. Tune in calibrator signal at 28.8 (.800 on tuning dial) and adjust all four capacitors marked 28.5 for maximum S meter reading.
10. Set Band switch to 21.0, tune in calibrator signal at 21.3, set Preselector to center of 15 meter marking and adjust all four capacitors marked 21.0 for maximum S meter reading.
11. Set Band switch to 14.0, tune in calibrator signal, at 14.3 set Preselector to center of 20 meter marking and adjust all four trimmer capacitors marked 14.0 for maximum S meter reading.
12. Set Band switch to 7.0 mc, tune in a signal at 7.3 mc, set Preselector to center of 40 meter marking and adjust all four capacitors marked 7.0 for maximum S meter reading.
13. Set Band switch to 3.5 mc, set Preselector to center of 80 meter segment and tune in a signal at 3.8 mc. Adjust all four trimmers marked 3.5 for maximum S meter reading.
14. Set Band switch to 1.5/3.0, set Xtal switch at #1 and set Preselector to 6. Tune in calibrator signal at 0.000 on the main tuning dial and tune all four trimmers marked 1.5/3.0 for maximum S meter reading.
15. Remove the two 10K resistors connected in step #1.

F. V.F.O. Output Coupler Adjustment

1. Attach an RF probe to the VTVM and connect it between ground and the junction of C110 and the coax cable. This point is located on a component board directly beneath the PTO assembly.
2. Set the VFO dial to .700.
3. Apply the alignment load from ground to the input terminal of T12 (the one with the 6.8 K resistor attached.)
4. Adjust T12 bottom for maximum VTVM indication.
5. Move the alignment load to the output terminal and adjust T12 top for maximum S-Meter reading.

G. 100 KC Calibrator Alignment

1. Attach the antenna to the R4 and tune in 2.5 mc WWV by setting the Band switch to 1.5/3.0, the Xtal switch to #1, the Main Tuning dial to 0.000 and the Preselector to 5.4.
2. Set the Function switch to CAL. (A shorted plug must be inserted in the Mute jack).
3. Adjust the calibrator adjust trimmer (C119) for zero beat with the unmodulated WWV carrier.

Note that C119 is located under the chassis on the component board on which the 100 KC crystal is mounted, and is accessible through a hole if bottom cover is in place.

H. V.F.O. Adjustment

The permeability tuned VFO was carefully adjusted at the factory and should require no further alignment.

If the PTO does not appear to track from one end of the range to the other, it should be returned to our plant for alignment. Maximum calibration error is 1 KC when calibrated at nearest 100 KC point.

If you notice the same error from one end of the band to the other and you cannot correct it with the movable dial index, the main dial may be slipped on its shaft enough to bring the calibration back into range.

I. Notch Filter Alignment

1. Tune in the crystal calibrator signal at any frequency for zero beat.
2. Set the Notch control to the center of its range.
3. Adjust the slug in T8 for minimum S-Meter reading.

J. Passband Tuner Alignment

1. Turn Passband tuning knob through its rotation and observe the travel of the four slugs visible from the rear of the tuner.
2. When these slugs are nearest the rear of the receiver, the Pass-

band tuning knob should be pointing horizontally to the left as viewed from the front. If it is not, loosen the knob set screw and reposition the knob.

3. Tune in a crystal calibrator signal at 3.8 mc for zero beat.
4. Set the Passband selector lever to .4 and set the Passband tuning knob to the center of the shortest line.
5. Attach a VTVM to the AVC test point (TP-2) and adjust the four slugs on the rear of the passband tuner for maximum AVC voltage.

IMPORTANT - - The passband tuner slugs have a considerable amount of spring when turned and this must be taken into consideration when the slugs are adjusted so as to obtain a true peak.

6. Set the Passband selector switch to 1.2 KC and turn off the crystal calibrator.
7. Turn the Passband knob through its range while observing the pitch of the received noise. Adjust the small screw on the rear of the tuner until the pitch of the noise is the same at the extreme ends of the control travel. (Pointer pointing horizontally to the left and to the right.)
8. Set the Passband selector lever to the 2.4 KC position and observe the pitch of the noise at the dots at the ends of the second line from the bottom. The pitch should be the same at either dot.
9. If it is not, turn the knob to the left dot and observe the pitch. Then rotate the control to the right until the pitch is the same.
10. Loosen the knob set screw and rotate the knob until it is halfway between its position at step 9 and the right dot.
11. Tighten set screw.

K. Checking Crystal Oscillator

1. Attach a VTVM to TP-3.
2. If the crystal inserted in the circuit is oscillating, a substantial negative voltage should be observed on the VTVM, (between -1.5 and -5 volts.)
3. If the crystal will not oscillate, a voltage of about -.6 will be observed.
4. The crystal oscillator circuit is not adjustable so if a particular crystal is not functioning, it is defective and should be replaced.

L. Bias and S-Meter Adjustment

1. Attach a VTVM to TP-2 and with the Preselector detuned and the antenna disconnected, adjust the RCVR SENS control, located on a component board directly behind T11, for -1.35 volts.
2. Remove VTVM and adjust S-Meter Zero control, located on the rear of the chassis, for a reading of "S-1" on the S-Meter.
3. Tune in the calibrator signal at 3.8 mc and peak Preselector.
4. Adjust the S-Meter Cal adjustment (R40) located on the component board mounted directly behind V5 for an S-Meter reading of 20 DB over S-9.