PRICE ONE DOLLAR

RCA Crystal-Calibrated Marker GENERATOR

Type WR-99A

- Operation
- Specifications
- Maintenance
- Applications

RADIO CORPORATION of AMERICA

ELECTRON TUBE DIVISION HARRISON, N. J.

(TEST EQUIPMENT, CAMDEN, N. J.)

Safety Precautions

The metal case of this instrument is connected to the ground of the internal circuit. For proper operation, the ground terminal of the instrument should always be connected to the ground of the equipment under test. The rf output cable has a shield throughout its entire length which is connected to the instrument ground and case. It is always best to handle the cable by the insulation.

An important point to remember is that there is always danger inherent in testing electrical equipment which operates at hazardous voltages. Therefore, the operator should thoroughly familiarize himself with the equipment under test before working on it, bearing in mind that high voltages may appear at unexpected points in defective equipment. Additional precautions which experience in the industry has shown to be important are listed below.

1. It is good practice to remove power before connecting test leads to high-voltage points. If this is impractical, be especially careful to avoid accidental contact with equipment racks and other objects which can provide a ground. Working with one hand in your pocket and standing on a properly insulated floor lessens the danger of shock.

2. Filter capacitors may store a charge large enough to be hazardous. Therefore, discharge filter capacitors before attaching test leads.

3. Remember that leads with broken insulation provide the additional hazard of high voltages appearing at exposed points along the leads. Check test leads for frayed or broken insulation before working with them.

4. To lessen the danger of accidental shock, disconnect test leads immediately after test is completed.

5. Remember that the risk of severe shock is only one of the possible hazards. Even a minor shock can place the operator in hazard of more serious risks such as a bad fall or contact with a source of higher voltage.

6. The experienced operator continuously guards against injury and does not work on hazardous circuits unless another person is available to assist in case of accident.

ITEMS

Supplied with WR-99A

1 Output Cable	1 Instruction Booklet
1 Warranty Registration Card	1 Phone Tip (black)
1 Phone Tip (Red)	1 RCA 0A2
1 RCA-6AF4-A	2 RCA-6AS6
2 RCA-6U8	1 RCA-6X4
1 10-Mc Crystal	1 4.5-Mc Crystal

1 RCA-12AT7

1B WR-99A (2) 12-60
Printed in U.S.A.

Description

The RCA WR-99A Crystal-Calibrated Marker Generator is designed for use in alignment and trouble-shooting of black-and-white and color-TV receivers, fm receivers, and other equipment operating in the frequency range from 19 to 260 Mc. The WR-99A provides an rf-output signal from 19 to 260 Mc in eight bands on fundamental frequencies. A wide choice of modulation facilities is provided, including 4.5 Mc, which produces dual markers on a sweep-response curve to mark the picture- and sound-carrier points on the curve.

An extremely versatile instrument, the WR-99A combines the functions of a marker generator, a horizontal bar pattern generator, a rebroadcast transmitter, and a heterodyne-frequency meter. The frequency of the internal variable-frequency oscillator, as well as the frequency of an external signal, may be checked with high accuracy against internally generated calibrating beats at 1- or 10-Mc intervals throughout the tuning range. The WR-99A includes a harmonic crystal oscillator and a 1-Mc oscillator which is coupled to the 10-Mc crystal oscillator for accuracy. Both these oscillators may be switched in or out from the front panel and provide audio calibrating beats from the speaker in the WR-99A. Calibration of the WR-99A may be checked at 242 intervals throughout the tuning range. Calibration of the instrument is straightforward; no charts are needed.

The tuning dial is specially marked with all vhf sound- and picture-carrier frequencies as well as important intermediate frequencies in the 20- to 30-Mc and 40- to 50-Mc regions. In addition, important color-TV frequencies are also marked on the dial scales.

In TV servicing, the WR-99A may be used in checking alignment and bandpass characteristics of rf and if circuits and the scanning linearity of vertical-deflection circuits. When the generator is set up as a rebroadcast transmitter, a video signal from an operating receiver may be used to modulate the rf output and provide an rf carrier complete with video and sync information. The output signal may then be used to check picture performance of other vhf TV receivers on any channel. The WR-99A may also be used to signal trace and trouble-shoot television receivers, and is useful in locating defective sections and stages.

When the generator is set up as a heterodyne-frequency meter, the frequency of an external signal may be determined quickly by feeding the signal into the WR-99A and zero beating it with the vfo signal. The frequency is then read directly from the dial scale.

A slide-switch type of attenuator is used with the WR-99A to provide attenuation in continuous steps over a range of 60 db on all frequencies. A special coaxial cable is provided with the unit for coupling into the test circuit.

Circuit design and layout provide a flexible system of modulating the rf output. For example, when the WR-99A is used in conjunction with a sweep generator and an oscilloscope to reproduce a sweep-response curve, the 4.5-Mc crystal oscillator will modulate the output from the WR-99A to produce dual markers spaced exactly 4.5 Mc apart on the curve. With output set to the frequency of the picture carrier, for example, the second marker will appear at the point on the curve corresponding to the sound-carrier frequency. The vfo signal also may be modulated internally with both 4.5 Mc and 600 cps, a useful feature for adjustment and alignment of sound-if amplifiers and detectors. The 600-cps modulation is also used to produce a horizontal-bar pattern when the output signal is set to the frequency of the picture carrier or picture intermediate frequency. The 4.5-Mc output signal may be modulated with 600 cps for visual alignment of the detector.

A special socket located at the rear of the WR-99A permits the connection of an external crystal or L-C circuit into one of the internal calibrating oscillators. When an external frequency-determining unit is used it is possible to produce calibrating beats at intervals other than 1 or 10 Mc.

The RCA WR-99A is designed for both general service and production use. The unit measures 10″ H x 13½″ W x 7″ D and weighs 17 pounds. The WR-99A is housed in a blue-gray hammeroid case with a satin-aluminum panel.

Specifications

Electrical

RF-Output Frequencies (fundamentals):

VFO Tuning Ranges	19-28 Mc	75-140 Mc
	27-40 Mc	140-180 Mc
	39-50 Mc	170-220 Mc
	50-90 Mc	200-260 Mc

Crystal Controlled .... 1 Mc, 4.5 Mc, 10 Mc

Output Voltages:

VFO Ranges .... at least 0.1 volt rms
Crystal Frequencies .... at least 0.05 volt rms

Tuning-Dial Characteristics:

RF tuning-dial ratio .... 3.5 to 1

RF Attenuator:

Range of attenuation .... 0 to 60 db
Number of steps .... 12 (5 db each)
Type of attenuator .... Matched-Impedance Pad

Output-Cable Impedance: .... 90 ohms

10-MC Crystal Calibrator:

Accuracy .... ±0.01%
Number of check points 24

1-MC Calibrator:

Accuracy .... ±0.01%
Number of check points 242

4.5-MC Crystal Oscillator:

Accuracy .... ±0.02%

Internal Modulation:

1 Mc, 10 Mc, 4.5 Mc, 4.5 Mc and 600 cps, 600 cps.

External Modulation:

From external source .... up to 10 Mc
From plug-in fundamental crystal .... 1 Mc to 30 Mc
From plug-in L-C circuit .... 100 Kc to 10 Mc

Tube Complement:

1 RCA-6AF4A .... Variable Frequency Oscillator
1 RCA-6AS6 .... Modulator
1 RCA-6U8 .... Audio Amplifier
1 RCA-12AT7 .... 10- and 1-Mc Oscillator
1 RCA-6U8 .... 4.5-Mc and 600-cps Oscillator
1 RCA-6AS6 .... Mixer
1 RCA-6X4 .... Rectifier
1 RCA-0A2 .... Voltage Regulator

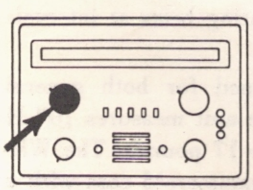
Power Supply:

Voltage .... 105-125 volts
Frequency .... 50-60 cps.
Power Consumption .... 45 watts

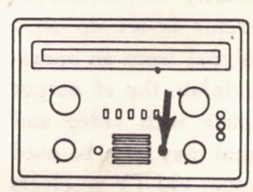
Mechanical

Height .... 10 inches
Width .... 13½ inches
Depth .... 7 inches
Weight .... 17 lbs.
Finish .... Blue-gray hammeroid case, satin-aluminum panel

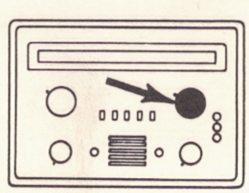
Functions of Controls



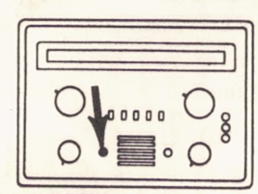
RF RANGE—Selects one of eight rf ranges from 20 to 260 Mc. This control simultaneously switches the internal oscillator circuits and rotates the dial drum so the corresponding frequency scale is in view.



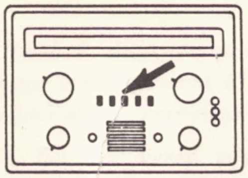
OUTPUT — The modulated or unmodulated rf output from the generator is available at this connector. The output connector accommodates the rf-output cable supplied with the instrument.



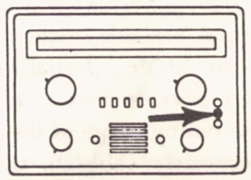
RF TUNING — Is a fine-tuning control used in conjunction with the RF RANGE control to select the desired output frequency.



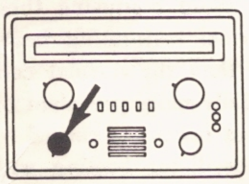
RF ON-OFF—When set to "OFF" position, removes B+ voltage from the variable-frequency oscillator and renders the oscillator inoperative. This control must be set to "OFF" to obtain the separate 1-, 4.5-, and 10-Mc output.



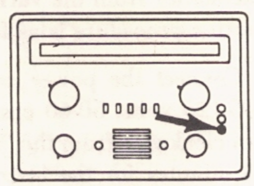
RF ATTENUATION—Utilizes five slide switches to provide step attenuation of the rf-output signal. When the slide switches are placed in their "down" positions, attenuation in steps of 15, 10, or 5 db is provided. When the switches are set to their "up" or "out" positions, no attenuation occurs. Because the attenuation provided by each switch is additive, the switches may be used to provide attenuation in any amount from zero to 60 db.



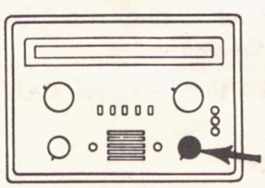
RF IN—External rf signal is fed in here when the WR-99A is used as a heterodyne frequency meter. This terminal connects to the rf detector. When an external signal is beat with the vfo or 1- or 10-Mc oscillator signal from the WR-99A, an audio beat note will be heard from the loudspeaker.



AF GAIN-POWER OFF—Turns power off when set to "POWER OFF" position; increases volume level from loudspeaker when turned clockwise.



MOD IN—External modulation signal to be superimposed on the rf output from the WR-99A is fed into this terminal. The MOD IN terminal connects directly to the internal modulator stage. When the RF ON-OFF control is set to "OFF" and the CAL/MOD control is set to "600∿", the internal 600-cps signal is available separately at this terminal.



CAL/MOD—Selects type of modulation applied internally or externally to the rf-output signal or made available at the output terminal. When this control is set to "OFF", no modulation is applied. When set to one of the seven remaining positions, modulation is as given below. NOTE: With the RF ON-OFF control set to "OFF", any type of modulation except "600∿", is available at the OUTPUT connector.

"10 MC CAL"—Crystal-controlled audio calibrating beats are provided at 10-Mc intervals at frequencies which are multiples of 10 Mc throughout the tuning range of the WR-99A. Makes possible precise calibration of the variable-frequency oscillator from 20 to 260 Mc.

"1 MC CAL"—Audio calibrating beats are provided at 1-Mc intervals at frequencies which are multiples of 1 Mc throughout the tuning range of the WR-99A. Makes possible calibration of the variable-frequency oscillator from 20 to 260 Mc.

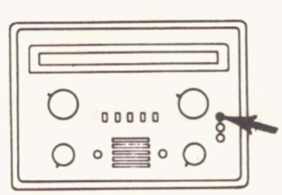
"1 MC & EXT CAL"—When a crystal or L-C circuit is plugged into the socket at the rear of the instrument, the external unit can be synchronized with the 1-Mc internal oscillator to give calibrating markers at intervals of less than 1 Mc. An audio beat signal will be heard from the speaker. NOTE: The crystal frequency must be at least 1 Mc or higher.

"EXT CAL"—When an external 1- to 30-Mc fundamental-frequency crystal is plugged into the socket at the rear of the instrument, the WR-99A will give harmonic output at frequencies which are multiples of the crystal frequency.

"4.5 MC MOD"—When the WR-99A is tuned to any frequency from 20 to 260 Mc, the 4.5-Mc modulation will appear as dual markers spaced exactly 4.5 Mc away from the vfo marker on a sweep-response curve. When the WR-99A is tuned to a picture-carrier frequency, the 4.5-Mc modulation will mark the sound-carrier frequency, or vice versa, on the response curve. NOTE: The 4.5-Mc markers cannot be heard as audio beats.

"4.5 MC & 600∿ MOD"—Applies both 4.5-MC and 600-cps modulation to the output signal. When the RF control is set to "OFF" and the CAL/MOD control is set to "4.5 MC & 600∿MOD", only these two modulating frequencies are available at the OUTPUT connector. This type of output is desirable for use in aligning sound-if amplifiers and FM detectors.

"600∿ MOD"—Imposes 600-cps audio modulation on the rf-output signal. When the output is tuned to the frequency of a TV picture carrier or picture intermediate frequency, the WR-99A may be used to produce approximately 6 to 11 horizontal bars on the picture-tube screen for checking vertical linearity. The 600-cps modulation is also used to align FM detectors by the "zero signal" method.



GND—connects directly to chassis ground and case.

Calibration and Operation

General

Before the WR-99A is put into use, it is important that the functions of controls and uses of the connectors be understood. The purposes of the controls and connectors are described under "Functions of Controls".

This section explains how to calibrate the WR-99A and how to set up the instrument to provide an unmodulated marker signal of a desired frequency, or a marker signal which is modulated with one or more different modulating signals. Some important suggestions are also given for connecting the WR-99A to the equipment under test and to auxiliary test equipment.

Because the Applications section does not include instructions for setting up and adjusting the WR-99A, the user should first make sure he understands the operation of the instrument before using it in alignment applications.

WR-99A Dial Scales

The 20 to 260-Mc tuning range of the WR-99A is divided into eight convenient tuning ranges (see Figure 2). The most-used frequencies in the intermediate-frequency and channel-frequency ranges are spotted individually on the scales. For example, 21.25 and 25.75 Mc are spotted on the first range and the intercarrier intermediate frequencies of 41.25 and 45.75 are spotted on the third range. In the TV-carrier ranges, the picture- and sound-carrier frequencies are spotted individually to facilitate alignment. All these frequency settings should be used only after the WR-99A has been calibrated against the nearest crystal check point, as described elsewhere in this section.

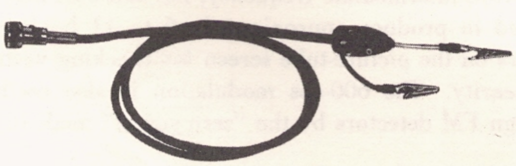


Figure 1. RF-output cable supplied with WR-99A.

Calibration

1-Mc and 10-Mc Calibration

Calibration of the WR-99A is necessary before the instrument can be used to provide accurate marker signals. Calibration is accomplished by beating the internal variable-frequency oscillator signal with either 1- or 10-Mc internal oscillator signals. These oscillators provide harmonic calibrating signals throughout the tuning range of the WR-99A. Thus, it is possible to accurately calibrate the WR-99A at 1-Mc or 10-Mc intervals from 20 to 260 Mc.

As the tuning dial is turned, beat notes other than those at 1- or 10-Mc intervals will be heard. It will be necessary to exercise care to avoid confusing these extra beat notes with the normal calibrating beats. These extra beats are weaker than the normal calibrating beat notes, and are usually more prevalent on the lower ranges. The extra beat notes are caused by harmonics of the calibrating oscillator beating with harmonics from the variable-frequency oscillator. Calibration procedure is as follows.

Connect the power cord to an ac outlet supplying 105-125 volts, 50-60 cps, and turn the AF GAIN control clockwise from the "POWER OFF" position. Allow 15 minutes for the instrument to reach a stable operating temperature.

1. Connect the output cable to the OUTPUT connector.

2. Set the RF RANGE control to the desired frequency range, as indicated on the dial scales.

3. Set the CAL/MOD control to the "10 MC CAL" position.

4. Set the RF control to "ON".

5. Adjust the RF TUNING control to position the dial pointer at the desired 10-Mc calibration point on the tuning dial. A strong beat note should be heard from the speaker. Carefully adjust the RF TUNING to obtain zero beat.

6. Observe the position of the dial pointer. If the pointer does not coincide exactly with the 10-Mc calibration mark on the tuning dial, slide the pointer, by means of the small knob at the bottom of the pointer, to the left or right, as required, to line the pointer up

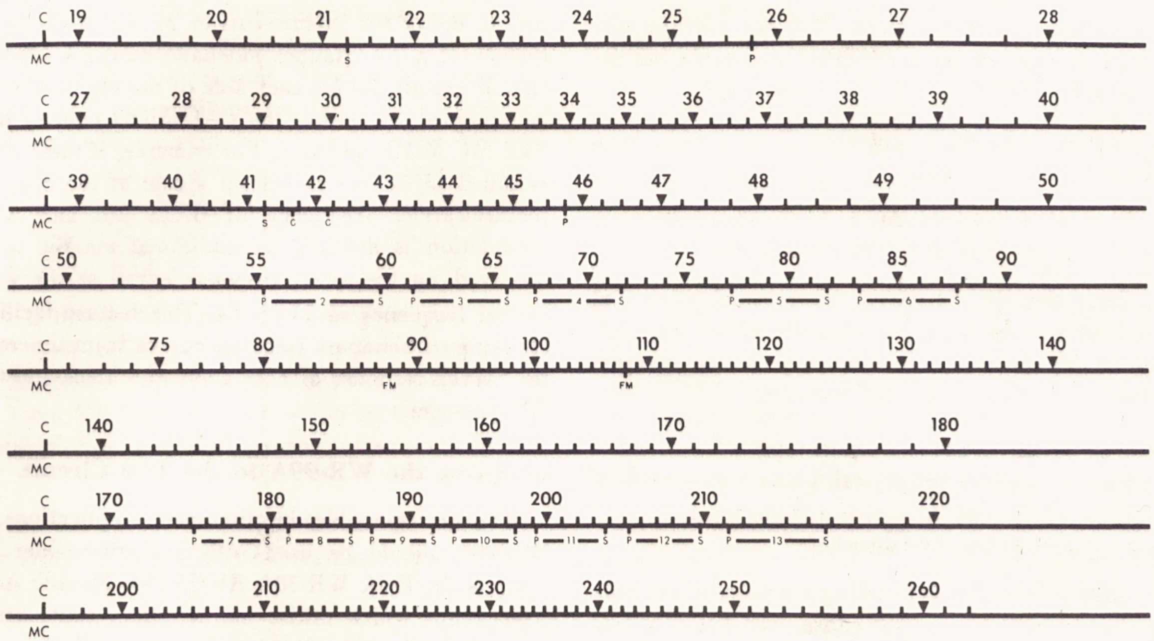


Figure 2. Dial scales for WR-99A. Note the most-used TV frequencies are spotted individually.

with the dial-scale calibration mark. NOTE: Leave the RF TUNING control set to the zero-beat setting while making this adjustment. The dial pointer has approximately 1 inch of play, permitting correct calibration at the nearest calibrating point.

After setting the dial pointer at the 10 MC check point which is closest to the desired frequency, set the CAL/MOD control to the "IMC CAL" position. Adjust the RF TUNING control to pick up the 1 MC beat at the point nearest the desired frequency. If the pointer does not coincide exactly with the 1 MC calibration mark on the tuning dial, slide the pointer to the left or right as required to line the pointer up with the dial scale calibration mark. Leave the RF TUNING control set for zero beat while making this adjustment. The calibration is now accurate at this 1 MC point and for some distance on either side.

The WR-99A should always be calibrated at the beat point which is nearest to the frequency to be used.

As an example, if it is desired to set the generator accurately to 45.75 MC, the procedure is as follows:

1. With the CAL/MOD control in the 10 MC CAL position, pick up the 50 MC beat on the 39 to 50 MC dial scale. Slide the pointer, if necessary, to coincide with the 50 MC dial scale calibration mark.

2. With the CAL/MOD control in the 1 MC CAL position, pick up the beat at 45 MC. Slide the pointer, if necessary, to coincide with the 45 MC dial scale calibration mark.

3. The calibration is now accurate at 45 MC. Adjust the RF TUNING control so that the pointer lines up with the 45.75 MC mark on the dial.

Calibration from an External Source

The two-pin socket in the rear of the WR-99A case (see Figure 4) connects to internal circuitry and permits use of an external crystal or L-C circuit in calibrating the WR-99A at other than 1- or 10-Mc intervals. In addition, when the vfo in the WR-99A is made inoperative the modulating signal of the external unit is available separately at the OUTPUT connector. For example, any fundamental-cut crystal in the range from 1 to 30 Mc or a Colpitts-type L-C circuit designed to operate from 100 Kc to 10 Mc, in which the point between the two capacitors is grounded, may be synchronized with the internal oscillator circuit. The external unit will produce audio beat signals up to about the tenth harmonic at frequencies which are multiples of the natural resonant frequency of the crystal or L-C circuit. In addition to these two special applications, an appropriate external unit may be synchronized with the internal 1-Mc crystal oscillator to give accurate calibrating beats at less than 1-Mc intervals. Procedure for using the external feature is as follows:

1. With power applied to the WR-99A and the output cable connected to the OUTPUT connector, set the RF control to "ON".

2. Set the CAL/MOD control to "EXT CAL". Turn up the AF GAIN control.

3. Plug a fundamental-cut 1- to 30-Mc crystal into the socket at the rear of the instrument case.

4. Tune the RF TUNING control and note that audio-beat signals occur at intervals which are multiples of the fundamental frequency of the external crystal, up to about the tenth harmonic.

NOTE: If an external Colpitts-type L-C circuit is connected in place of the crystal, ground the center of the two capacitors by means of a soldering lug to the screw adjacent to the crystal socket.

To obtain locked-in calibrating markers at less than 1-Mc intervals, the same procedure used above should be followed except that the CAL/MOD control is set to "1 MC & EXT CAL" and an L-C circuit must be used. The external L-C circuit must be an exact submultiple of 1 Mc to avoid the generation of an excessive number of intermediate beat notes. For example, an 0.25-Mc L-C circuit can be plugged in and adjusted by means of a tunable slug in the coil to zero beat with the 1-Mc crystal in the WR-99A to give 0.25-Mc check points throughout the tuning range of the WR-99A. In all these applications described above, the external crystal or L-C circuit will give sideband markers when the RF control is set to "ON". When the RF control is set to "OFF", the modulating signal is available separately at the OUTPUT connector.

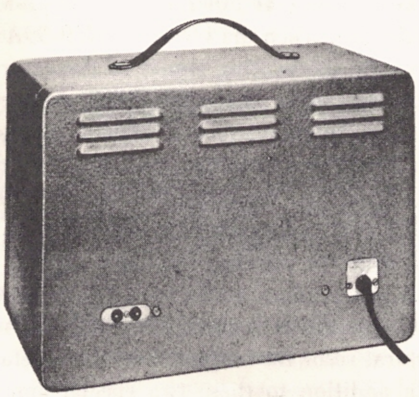


Figure 3. Rear socket for connection of external crystal or Colpitts-type L-C circuit.

Use of 4.5-Mc Sideband Markers

When the WR-99A is set up to deliver an output signal on either the picture-carrier or sound-carrier frequency of a TV channel, sideband markers which are spaced exactly 4.5-Mc each side of the vfo marker may be obtained by setting the CAL/MOD control to the "4.5 MC MOD" position. For example, if the WR-99A is tuned to deliver an output signal at the channel 4 picture-carrier frequency of 67.25 Mc and 4.5-Mc modulation is applied, an additional marker will be observed on the sweep-response curve at the sound-carrier frequency of 71.75 Mc. This feature facilitates checking of bandpass response curves from tuners and the overall response of both color and black-and-white TV receivers.

Coupling the WR-99A to the Test Circuit

Wherever possible in alignment applications, the WR-99A should be used with a marker-adder unit, such as the RCA WR-70A RF/IF/VF Marker Adder. Test setups which utilize marker-adder units are described in the "Applications" section. If the signal from the WR-99A is coupled directly into the test circuit, the recommendations which follow should be observed.

The rf-output cable provided with the WR-99A should always be used for coupling the instrument to other equipment. The cable is shielded throughout its length to prevent excessive radiation of the output signal and to minimize hum pickup. The output clip should be connected as closely as possible to the point of signal injection and the ground clip should be grounded close to the injection point. When the marker is fed into the tuner, the ground should be connected to the tuner shield. Do not connect the output cable to any circuit containing B+ voltage. Failure to observe this precaution may result in damage to the WR-99A.

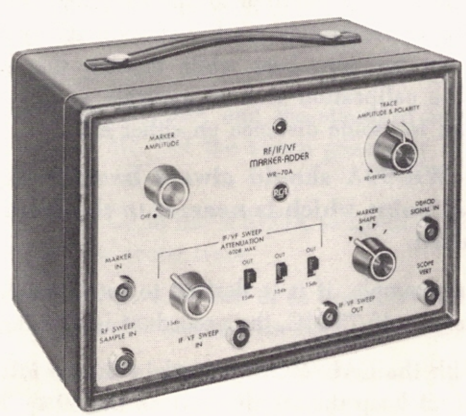


Figure 4. RCA WR-70A Marker Adder.

When the WR-99A is used to provide a marker for a high-gain circuit, such as a TV receiver, direct connection of the cable to the injection point may not be necessary. Often, it is sufficient to lay the output clip near the injection point, or to connect both clips to the chassis near the injection point. This arrangement has the advantage of extremely low circuit loading but has the disadvantage of possible injection of the signal into adjacent circuits. For overall alignment, the marker may be coupled into the receiver by connecting the output cable directly to the antenna terminals, to the tuner mixer stage, or to the grid circuit of the first picture-if stage.

One of the best methods of injecting the signal into the if strip consists of lifting up the shield on the tuner mixer tube and clipping the rf-output cable to the tube shield. The shield should be kept in an elevated position to prevent shorting the injected signal to ground. The ground clip should be connected to the tuner shield. With this method of injection, the marker is capacitively coupled into the circuit through the capacitance between the tube shield and the plate of the mixer tube. It may be necessary to increase the rf output from the WR-99A when this procedure is used. The advantage of this method is that circuit loading is slight compared with direct-coupling methods, and distortion of the sweep curve is minimized.

Another method consists of clipping directly to the insulated portion of the grid lead of the mixer stage. Unless care is taken when this method is used, however, detuning of the high impedance mixer circuits may occur and result in a distorted sweep curve and an erroneous picture of alignment.

In general, the RF OUTPUT attenuator should be set to give the smallest amount of output necessary to obtain a marker of the desired height on the response curve. If too strong a marker signal is injected into the circuit under test, it is possible that overloading may cause distortion of the curve and result in an erroneous picture of the alignment. The vertical gain control on the oscilloscope should be set at or near the maximum gain point so the oscilloscope furnishes a good share of the signal amplification. If this technique is used, the amount of injected signal can be kept low.

Application

General

Eliminating AGC Action

Because the agc voltage in a TV receiver varies in accordance with the signal fed through the if amplifier to the agc rectifier, a varying dc voltage is present on the agc bus. This voltage is applied to the grids of some or all of the if-amplifier tubes and may also be fed to the grid of the rf amplifier tube. If this voltage is not rendered inoperative during alignment, difficulty may be experienced in shaping the response curve, and final results may be misleading.

This difficulty may be avoided by either disconnecting the agc system or rendering it inoperative through application of an external amount of fixed bias which is the same as that provided during normal operation of the agc system. The RCA WG-307A TV Bias Supply (See Figure 5) is recommended. This supply furnishes three output voltages continuously adjustable from 0 to —15 volts, as well as —100 volts (fixed) for use in color-TV receivers.

If the RCA WR-69A Television/FM Sweep Generator is employed in the alignment setup, bias may be taken from the bias-supply terminals on the generator. In addition to being a valuable aid during if alignment, the external bias voltages are highly useful in tracking down trouble in agc circuits.

Alignment Test Setups

In sweep-frequency alignment, the sweep generator is tuned to sweep the band of frequencies normally passed by the wide-band circuits in the TV receiver, and a trace representing the response characteristics of the circuits will be displayed on the oscilloscope. The WR-99A is used to provide calibrated markers along the response curve for checking the frequency settings of traps, adjustment of capacitors and coils, and for measuring overall bandwidth of the receiver.

When the marker signal from the WR-99A is coupled into the test circuit, a vertical "pip" or marker will appear on the curve. When the WR-99A is tuned to a frequency within the pass band accepted by the receiver, the marker will indicate the position of that frequency on the sweep trace. The technician then adjusts the circuit components to obtain the desired waveshape, using the different frequency markers as check points.

The order in which various sections of the television receiver should be aligned may differ between different models of receivers. In all cases, the alignment order given by the manufacturer in his service notes should be followed.

It is not possible, therefore, to recommend a single alignment procedure which can be applied with equal success to all television receivers. Instead, the application data given in the following pages are designed for use in conjunction with the manufacturer's service notes to aid the technician in aligning a receiver correctly and efficiently.

Receiver alignment requires, in addition to the WR-99A Calibrator, a sweep generator having essentially flat output and good sweep linearity, a cathode-ray oscilloscope, and a vacuum-tube voltmeter. An RCA WR-69A or WR-59-series Sweep Generator, an RCA WO-91A Oscilloscope, and an RCA VoltOhmyst*, such as the WV-77E, WV-87B, or WV-98B are recommended. A marker-adder unit, such as the RCA WR-70A RF/IF/VF Marker Adder, can be used to advantage in the alignment setup.

Tuner Alignment

To clear up any misconception that a tuner is a complicated device, consider the tuner when stripped to its essentials. Except for the switching arrangement and the usual high and low-pass filters, it is about as simple as the input of a broadcast receiver. This fact should be remembered when trouble-shooting problems arise which are common to all channels. In these cases, it is good practice to work with the tuner set to only one channel position until the trouble is corrected. Afterwards, other channel positions can be compared

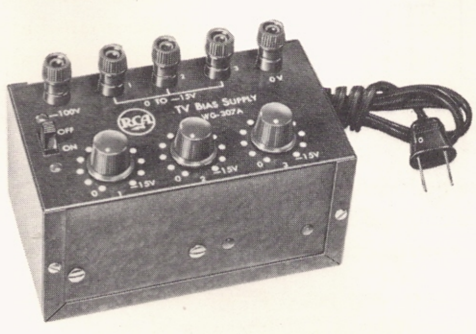


Figure 5. RCA WG-307A TV Bias Supply.

*TMK Reg. U.S. Pat. Off.

with the initial one for sensitivity, switching noise, and general performance.

If the tuner is satisfactory in these respects, it is advisable to check the alignment by observing the response curves for each channel. Curves for the individual channels should be examined and compared with those shown in the manufacturer's service notes. If a response-curve check indicates that alignment is required, the technician should refer to the alignment curves given in the service notes as guides and follow closely the recommended alignment procedure.

Alignment should not be attempted until these preliminary tests have been completed. Futhermore, the technician should be aware that most tuners, unless tampered with, are correctly aligned. This knowledge can often prevent misalignment of a good tuner.

The primary purpose of alignment is to obtain a response curve of proper shape, frequency coverage, and gain. Most tuners merely require "touch-up" alignment in which relatively few of the adjustments are used. Generally, complete over-all alignment is required only when a person with inadequate knowledge or equipment has worked on the tuner. For a complete alignment job, it is desirable to follow a specific sequence of adjustments, the sequence depending upon the type of tuner. However, where only touch-up alignment is required, the sequence of adjustment is usually unimportant.

In principle, complete front-end alignment includes alignment of the antenna input circuits and adjustment of the amplifier and rf oscillator circuits. The antenna input circuits are usually aligned to give a response curve which has a sharp drop-off slightly below channel 2 and which is flat up through channel 13.

In effect, the input circuits, which consist of two or more traps and high-frequency peaking circuits, act as a high-pass filter. Their correct alignment is important in keeping low-frequency interference from entering the receiver through the tuner circuits. Adjustment of the input circuits is usually critical but they seldom require service.

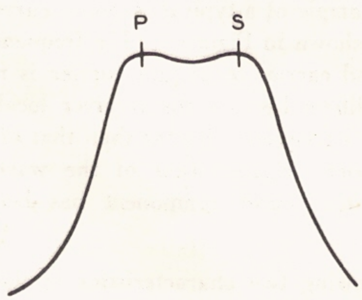


Figure 6. Typical tuner curve for channel 8.

Alignment of the rf amplifier and oscillator stages, however, is a more familiar job. Adjustments include setting the oscillator frequencies for channels 2 through 13, setting one or more traps to their correct frequencies, and adjustment of tracking with the rf amplifier. The converter transformer may also require adjustment along with the tuner.

All these adjustments require that a sweep signal from the sweep generator and a marker signal from the WR-99A be fed into the tuner so that a response curve with markers will be reproduced on the oscilloscope screen. Alignment is accomplished by setting adjustments so the waveshape on the oscilloscope screen resembles the waveshape shown by the manufacturer in his service notes. The notes show separate curves for each of the 12 channels. Each channel is aligned separately to obtain the desired curve shape. The marker signals from the WR-99A are used to provide frequency reference points to aid in shaping the curve.

With the sweep generator set to deliver output on channel 8, for example, and 4.5-Mc interval markers injected from the WR-99A at 181.25 and 185.75 Mc, a typical tuner curve for channel 8 will resemble that shown in Figure 6. The markers on the curve show the separation between the picture and sound carriers. Since the rf sections of the TV receiver must pass both sound and picture signals, a bandpass of approximately 6 Mc is required. The locations of the sound and picture carrier frequencies for all vhf channels, which are shown in Table I (page 17), are individually marked on the dial scales.

A necessary preliminary to alignment is a check of the test setup. For example, rf bias should be checked and proper connection points for test equipment determined. All equipment should be given a 20-minute warm-up time to enable circuits to stabilize operation.

If the tuner is to be aligned in the receiver, the tuner curves should be observed with the first if-amplifier stage out of operation. Removal of the first if-amplifier tube is generally sufficient to avoid any curve distortion caused by the if amplifier. In some tuners, resonance in the mixer plate circuit may also produce undesirable reflections. Generally, to remedy this situation, the picture-if amplifier input must be loaded or the if-transformer primary must be detuned.

The tuner oscillator should be in operation during alignment. If it is not, the lack of oscillator injection voltage at the mixer grid will alter the mixer bias, resulting in an increase in amplitude of the response curve and distortion of the waveshape. The oscillator frequency of intercarrier-type receivers should be checked by use of the heterodyne-frequency meter method or the method recommended by the receiver manufacturer.

Serious misalignment of the tuner or considerable difficulty or failure in alignment may indicate a defective component. If proper alignment procedure fails to produce correct tuner curves, the technician should check individual components in the rf unit.

Over-all Picture-IF Alignment

The general procedure for if alignment of split-sound and intercarrier types of television receivers is the same; the major differences being in the number of intermediate frequencies used and the frequencies employed. As in tuner alignment, the procedure described in the manufacturer's service notes should be followed carefully and response waveforms checked against those shown in the service notes.

If a television receiver is to give wide-band amplification to the television signal, the picture-if system of the receiver must pass a frequency band approximately 3.5 to 4 Mc wide. This is necessary to insure that all the video information is fed through to the kinescope grid and that the resultant picture has full definition.

The bandpass of color TV receivers must be essentially flat to beyond 4 Mc to insure that color information contained in the color side bands is not lost. Two special marks are provided on the WR-99A dial to aid in checking alignment. One mark is placed at 42.17 Mc, the color sub-carrier intermediate frequency. The other mark is placed at 41.65 Mc, which is the "knee" or drop-off point on the response curve.

The sweep generator, marker generator, and the oscilloscope provide the means for determining the shape of the response curve and the width of the bandpass. With the equipment set up to obtain a response curve, the WR-99A is used to check the bandwidth directly in terms of frequency as follows.

Tune the WR-99A so the marker falls at a point approximately 70% up the curve slope. Read the frequency at this point directly from the marker generator dial scale. Tune the generator so the marker appears on the opposite side of the bandpass curve at the 70% response point. The frequency is read from the dial scale. The difference between the two settings is equal to the bandwidth of the amplifier.

Two kinds of picture-if systems are generally used to give the necessary bandwidth. The overcoupled if system employes transformers which have their primary and secondary windings tuned to the same frequency. The transformers are overcoupled to obtain a flat-topped response curve of the desired bandwidth. The other method, the stagger-tuned system, employs transformers (coils) which are stagger tuned to different frequencies to produce a final over-all if response of the desired bandwidth. Some television receivers employ if systems which utilize both these principles. It is important, then, that the alignment instructions given in the service notes be followed closely.

To obtain an over-all picture-if response curve, connect the direct probe of the oscilloscope across the second-detector load resistor, which provides a demodulated signal to the oscilloscope. Connect the ground cable to the receiver chassis. Because of the high degree of signal amplification in the if-amplifier section, the oscilloscope gain may need to be reduced to a low level, but not to the point where it is necessary to use a high level of output from the sweep generator.

An over-all if response curve may be obtained by feeding the if sweep signal into the amplifier at the input to the first if stage or into the mixer stage. If the markers from the WR-99A are injected into the same point, intermediate marker frequencies should be used.

Manufacturer's procedure usually calls for stage-by-stage alignment, starting with the last if stage and working forward. Sometimes it may be necessary to change the sweep oscillator injection point to the grid of the stage being aligned, or to the plate of the stage preceding the stage being aligned. This insures that the response curve is not affected by characteristics of forward, misaligned stages. As the grid and plate tuning adjustments of each stage are checked, the frequency of the if marker is changed accordingly.

Analysis of the Sweep-Response Curve

As an example of a typical response curve for a TV receiver is shown in Figure 7. The frequency relation of the sound carrier to picture carrier is reversed in the if amplifiers because the receiver local oscillator operates at a frequency higher than that of the transmitted carrier. Examination of the waveform will show that the sound component has been sharply attenuated.

The following two characteristics of the picture-if response curve should be noted: (1) the picture-carrier is set at approximately 50% of maximum response and

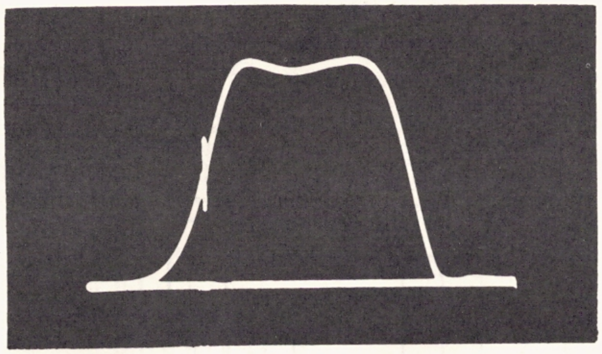


Figure 7. Sweep-response curve for picture-if amplifier and detector. Marker shows picture-carrier frequency.

(2) the sound carrier frequency must be at 1.0% or less of maximum response. The picture carrier is placed at approximately 50% of maximum response because of the nature of single sideband transmission, the system used in transmitting television signals. If the circuit is adjusted to put the picture carrier too high on the response curve, the effect will be a general decrease in picture quality caused by the resulting low-frequency accentuation; placing the picture carrier too low on the curve will cause loss of the low-frequency video response and result in poor definition. Loss of blanking and proper synchronization will also occur.

The skirt selectivity of the picture-if curve is made sharp enough to reject the sound component of the composite signal. The sound carrier is kept at a low level to prevent interference with the video signal. To achieve this selectivity in split-sound receivers, an absorption circuit, consisting of a trap tuned to the sound intermediate frequency, is used. Some receivers include additional traps tuned to the higher frequency of the adjacent channel sound carrier. These traps have a marked effect on the shape of the response curve. Alignment of traps is described under the heading, "Trap Alignment".

Checking Response of Individual Stages

The response of individual if-amplifier stages or of two or more stages together may be checked by setting up the sweep generator and WR-99A as shown in Figure 8. The sweep signal is fed into the stage immediately preceding the stage being checked. The response curve is checked on the oscilloscope, which is connected across the second-detector load resistor. Before attempting sweep alignment of the amplifier section, the agc circuit should be rendered inoperative by either disconnecting the agc bus or by using a bias box, as described in the section, "Eliminating AGC Action".

The rf cable from the sweep generator is connected to the grid of the if-amplifier stage ahead of the stage to be checked to isolate the test equipment from the stage being checked. The rf output cable should not be connected to the grid of the stage being checked because even slight loading of the high-impedance grid circuit may cause a change in circuit impedance and result in distortion of the normal response characteristic. The marker signal from the WR-99A should be fed to the grid of the mixer tube.

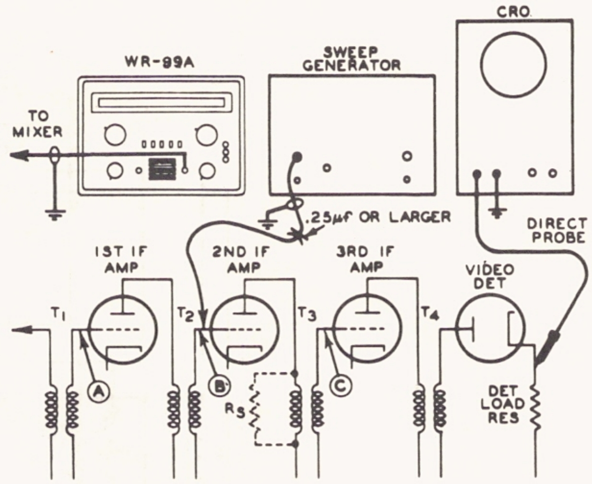


Figure 8. Method for checking response of third if-amplifier stage and detector.

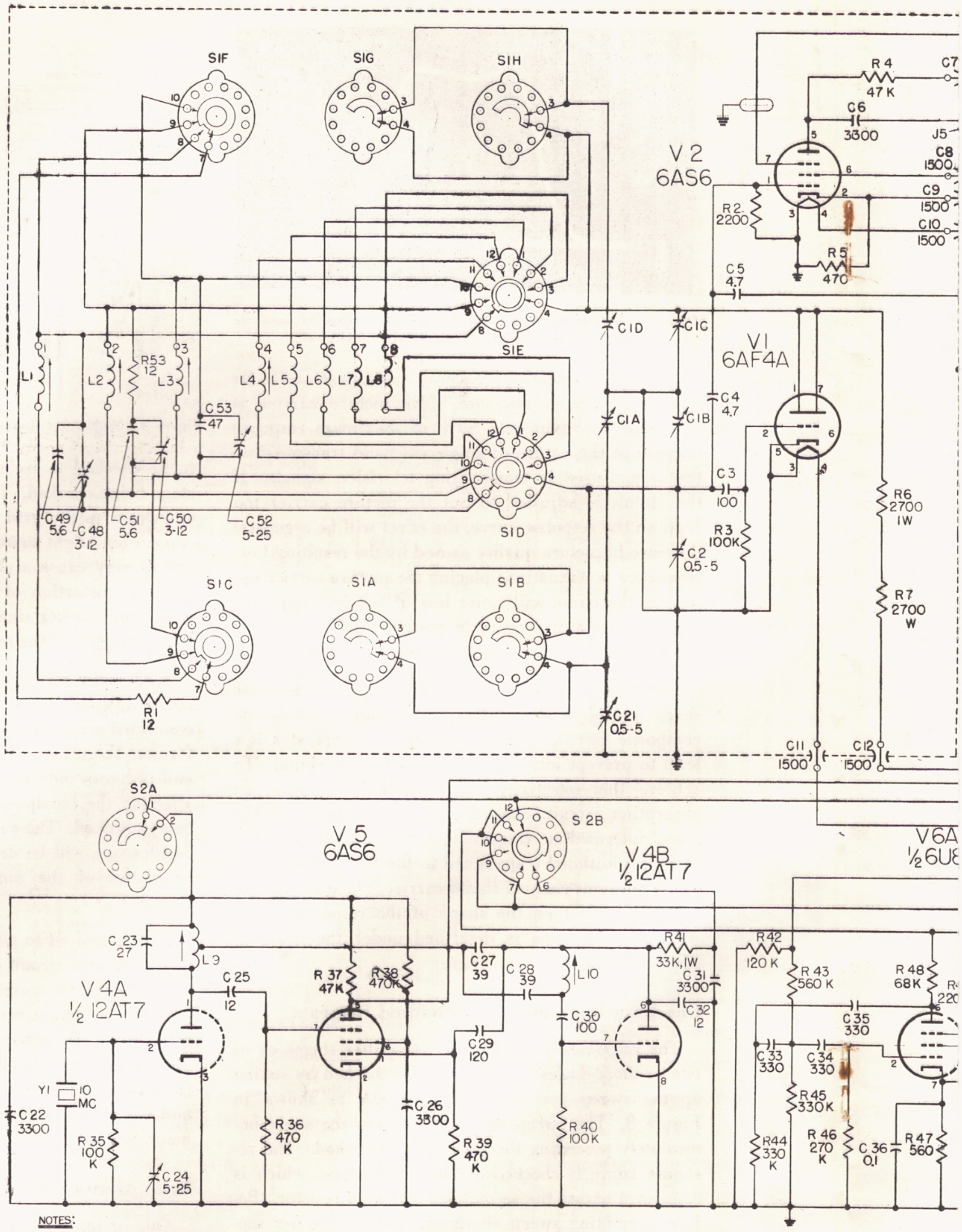
With equipment set up as shown in Figure 8, a resistor of small value, such as 470 ohms, should be connected across the primary of the following if transformer. The resistor acts to swamp the primary winding and prevents inductive reactance of the winding from affecting the bandpass characteristics of the amplifier being checked. The shape of the response curve on the oscilloscope will be determined by the bandpass characteristics of the amplifier stage and the detector circuits.

If it is desired to check the bandpass characteristics of the detector circuit only, the sweep generator output cable should be moved from point "B" to point "C" and the swamping resistor, R_s, placed across the primary of T4. Response of the second and third if amplifier stages and the detector stage together may be checked by moving the rf output cable to point "A" and connecting the swamping resistor across the primary of T2.

Trap Alignment

One or more traps may be contained in the rf unit and picture and sound if amplifiers, depending upon the type of receiver. Traps are included to attenuate specific frequencies, such as adjacent picture and sound carriers, or picture- and sound-if signals in various parts of the receiver.

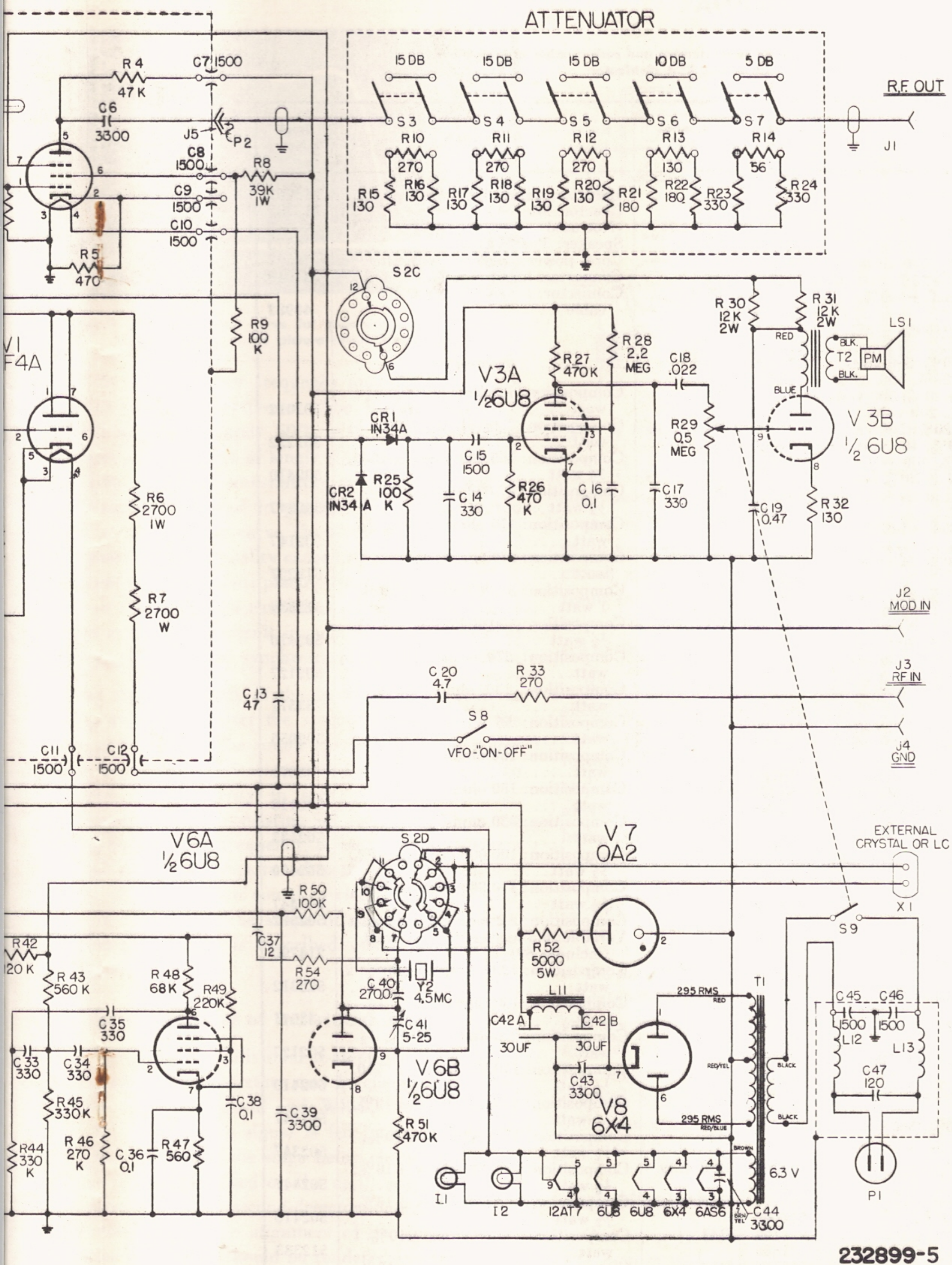
(Continued on page 18)



NOTES:

1. ALL RESISTANCE VALUES ARE IN OHMS EXCEPT AS NOTED.
2. CAPACITANCE VALUES LESS THAN 1.0 ARE IN UF & 1.0 & ABOVE ARE IN UUF EXCEPT AS INDICATED.
3. SWITCH S1 & S2 VIEWED FROM FRONT WHEN IN MAX. COUNTERCLOCKWISE POSITION.
4. ALL VOLTAGES MEASURED WITH A "VOLTOHMYST."

Schematic Diagram of WR-



matic Diagram of WR-99A

Replacement Parts List

WR-99A

When ordering replacement parts, include serial number and code number of instrument. Order parts through a local RCA distributor.

Symbol No.	Description	Stock No.
	Capacitors	
C1A C1B C1C C1D	Variable: 4 sections	214769
C2	Trimmer: 0.5-5 μμf	93463
C3	Mica: 100 μμf ±10%, 500 volts	103856
C4 C5	Headed lead: 4.7 μμf ±20%, 500 volts	102235
C6	Ceramic disc: 3300 μμf +100% −0%, 500 volts	213734
C7 to C12	Ceramic: 1500 μμf +100% −0%, 500 volts	214789
C13	Ceramic: 47 μμf ±20%, 500 volts	75609
C14	Ceramic: 330 μμf ±20%, 500 volts	75792
C15	Ceramic: 1500 μμf ±20%, 500 volts	75610
C16	Paper: 0.1 μf ±20%, 200 volts	73784
C17	Ceramic: 330 μμf ±20%, 500 volts	75792
C18	Paper: 0.022 μf ±20%, 400 volts	73562
C19	Paper: 0.47 μf ±20%, 400 volts	78977
C20	Headed lead: 4.7 μμf ±20%, 500 volts	102235
C21	Trimmer: 0.5-5 μμf	93463
C22	Ceramic disc: 3300 μμf +100% −0%, 500 volts	213734
C23	Ceramic: 27 μμf ±10%, 500 volts	205918
C24	Variable: 5-25 μμf	204811
C25	Ceramic: 12 μμf ±20%, 500 volts	94228
C26	Ceramic disc: 3300 μμf +100% −0%, 500 volts	213734
C27 C28	Ceramic: 39 μμf ±10%, 500 volts	75450
C29	Ceramic: 120 μμf ±20%, 500 volts	76347
C30	Ceramic: 100 μμf ±10%, 500 volts	214787
C31	Ceramic disc: 3300 μμf +100% −0%, 500 volts	213734
C32	Ceramic: 12 μμf ±10%, 500 volts	214792
C33 C34 C35	Ceramic: 330 μμf ±20%, 500 volts	75792
C36	Paper: 0.1 μf ±20%, 200 volts	73784
C37	Ceramic: 12 μμf ±20%, 500 volts	94228
C38	Paper: 0.1 μf ±20%, 200 volts	73784
C39	Ceramic disc: 3300 μμf +100% −0%, 500 volts	213734
C40	Ceramic: 2700 μμf ±20%, 500 volts	214791
C41	Variable: 5-25 μμf	204811
C42A C42B	Electrolytic: 30-30 μf +100% −10%, 350 volts	214788
C43	Ceramic: 3300 μμf +100% −0%, 500 volts	213734
C44	Ceramic disc: 3300 μμf +100% −0%, 500 volts	213734
C45 C46	Ceramic disc: 1500 μμf +100% −0%, 500 volts	73748
C47	Ceramic: 120 μμf ±20%, 500 volts	76347
C48	Variable: 3-12 μμf	56231
C49	Ceramic: 5.6 μμf ±1.0 μμf, 500 volts	74182
C50	Variable: 3-12 μμf	56231
C51	Ceramic: 5.6 μμf ±1.0 μμf, 500 volts	74182
C52	Variable: 5-25 μμf	204811
C53	Ceramic: 47 μμf ±10%, 500 volts	77531
	* * * * * *	
CR1 CR2	Crystal: type 1N34-A	59395
E1	Post, binding	212151
J1	Connector: RF Output	96257
J2 J3	Jack: Mod In and RF In	214783
J4	Jack: single contact	214782
J5	Connector	51388
L1	Inductor, adjustable	214766
L2	Inductor, adjustable	214765
L3	Inductor, adjustable	214764
L4	Inductor, adjustable	214764
L5	Inductor, adjustable	214763
L6 to L9	(Not used)	——
L10	Inductor, adjustable	214767
L11	Reactor, filter: 13.35 H	213732
L12 L13	(Not used)	——
LS1	Speaker: 3″ PM type	76373
P1	Cord, power: 78″ long, with plug	70392
P2	Connector: for attenuator	31048
P501	Connector: coaxial-type, for RF cable	48982
	Resistors	
R1	Composition: 12 ohms ±10%, ½ watt	502012
R2	Composition: 2200 ohms ±10%, ½ watt	502222
R3	Composition: 100,000 ohms ±10%, ½ watt	502410
R4	Composition: 47,000 ohms ±10%, ½ watt	502347
R5	Composition: 470 ohms ±10%, ½ watt	502147
R6 R7	Composition: 2700 ohms ±10%, 1 watt	512227
R8	Composition: 39,000 ohms ±10%, 1 watt	512339
R9	Composition: 100,000 ohms ±10%, ½ watt	502410
R10 to R12	Composition: 270 ohms ±10%, ½ watt	502127
R13	Composition: 130 ohms ±5%, ½ watt	33571
R14	Composition: 56 ohms ±10%, ½ watt	502056
R15 to R20	Composition: 130 ohms ±5%, ½ watt	33571
R21 R22	Composition: 180 ohms ±10%, ½ watt	502118
R23 R24	Composition: 330 ohms ±10%, ½ watt	502133
R25	Composition: 100,000 ohms ±10%, ½ watt	502410
R26 R27	Composition: 470,000 ohms ±10%, ½ watt	502447
R28	Composition: 2.2 meg ±10, ½ watt	502522
R29	Variable: 0.5 meg ±20%, ¼ watt (includes S9)	214790
R30 R31	Composition: 12,000 ohms ±10%, 2 watt	522312
R32	Composition: 130 ohms ±5%, ½ watt	33571
R33	Composition: 270 ohms ±10%, ½ watt	502127
R35	Composition: 100,000 ohms ±%10, ½ watt	502410
R36	Composition: 470,000 ohms ±10%, ½ watt	502447
R37	Composition: 47,000 ohms ±10%, ½ watt	502347
R38 R39	Composition: 470,000 ohms ±10%, ½ watt	502447
R40	Composition: 100,000 ohms ±10%, ½ watt	502410
R41	Composition: 33,000 ohms ±10%, 1 watt	512333
R42	Composition: 120,000 ohms ±10%, ½ watt	502412
R43	Composition: 560,000 ohms ±10%, ½ watt	502456
R44 R45	Composition: 330,000 ohms ±10%, ½ watt	503433

Symbol No.	Description	Stock No.
R46	Composition: 270,000 ohms ±10%, ½ watt	502427
R47	Composition: 560 ohms ±10%, ½ watt	502156
R48	Composition: 68,000 ohms ±10%, ½ watt	502368
R49	Composition: 220,000 ohms ±10%, ½ watt	502422
R50	Composition: 100,000 ohms ±10%, ½ watt	502410
R51	Composition: 470,000 ohms ±10%, ½ watt	502447
R52	Wire Wound: 5000 ohms ±20%, 5 watt	205065
R53	Composition: 12 ohms ±10%, ½ watt	502012
R54	Composition: 270 ohms ±10%, ½ watt	502127
R501	Composition: 91 ohms, ½ watt (for RF cable)	47452
	* * * * * *	
S1	Switch, rotary: 4 sections, 8 positions, 12 circuits	214798
S2	Switch, rotary: 2 sections, 8 positions 5 circuits	214770
S3 to S7	Switch, slide: DPDT, 0.5 amp, 125 volts	214469
S8	Switch, toggle: SPST, 6 amps. 125 volts; 3 amps, 250 volts	214760
S9	(Part of R 29)	——
T1	Transformer, power	214793
T2	Transformer, audio output	37806
X1	Socket, crystal	214781
Y1	Crystal: 10 Mc	214795
Y2	Crystal: 4.5 Mc	214796

Symbol No.	Description	Stock No.
	Miscellaneous	
	Bezel: polystyrene, silver	214785
	Cable, rf-output: complete	214797
	Capacitor: ceramic-disc, 10,000 μμf +100%, −0%, 500 volts	73960
	Clip alligator: for rf cable	35262
	Foot, rubber: for carrying case	211887
	Handle, carrying	212102
	Insulator: black, for alligator clip	99539
	Insulator: red, for alligator clip	204879
	Knob, control: 15/16″ dia, blue	212148
	Knob, control: 1¼″ dia, with pointer, blue	214778
	Knob, control: 1¼″ dia, blue	214779
	Lamp: 6.3 volts	11891
	Pointer assembly: complete with slider, slider spring, pointer handle, and pointer	214772
	Pulley, dual: 1″ O. D. x 1 5/16″ long	214777
	Pulley, single: ¼″ x 1.5″ dia	214776
	Pulley, drive: for tuning shaft, 2″ dia x 1.4″ wide	204480
	Pulley, single: ¼″ thick x 2⅛″ dia	214775
	Pulley, single: 5/16″ thick x 3 5/32″ dia	214774
	Pulley, single: 9/64″ thick x ⅝″ dia, aluminum	214761
	Pulley, single: 9/64″ thick x ½″ dia, aluminum	214762
	Scale, dial: calibrated	214768
	Shell: for rf cable, match pair	47452
	Socket, tube: 7-pin	204899
	Socket, tube: 9-pin	204900
	Socket, pilot lamp	214780
	Spring, coil: 0.156″ dia x 9/16″ long	214784
	Spring, coil: 0.185″ dia x 1″ long	214771
	Stud: for carrying handle	214786
	Window: for dial	214773

TABLE I

Channel No.	Channel Freq. (Mc)	Picture-Carrier Freq. (Mc)*	Sound-Carrier Freq. (Mc)†
2	54-60	55.25	59.75
3	60-66	61.25	65.75
4	66-72	67.25	71.75
5	76-82	77.25	81.75
6	82-88	83.25	87.75
7	174-180	175.25	179.75
8	180-186	181.25	185.75
9	186-192	187.25	191.75
10	192-198	193.25	197.75
11	198-204	199.25	203.75
12	204-210	205.25	209.75
13	210-216	211.25	215.75

*Values given in this column are identified on dial scale as "2P", "3P", etc.

†Values given in this column are identified on dial scale as "2S", "3S", etc.

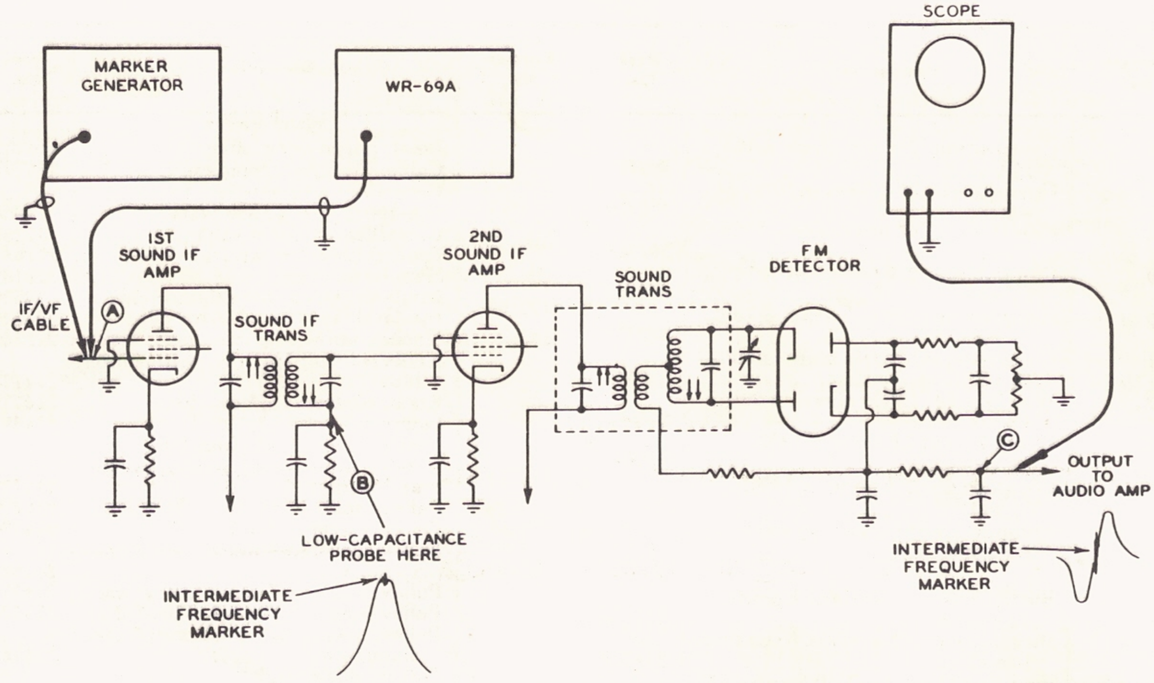


Figure 9. Test-equipment setup for alignment of sound-if amplifier.

The test-equipment setup for alignment of traps in the if amplifier is the same as that used in conventional if alignment described above. A sweep-response curve is obtained on the oscilloscope screen, and a marker from the WR-99A, which is set to the frequency of the trap, is fed into the mixer stage.

Because the response of the amplifier is very low at the trap frequencies, the marker may often be difficult to see on the response curve. The use of a marker-adder unit, such as the RCA WR-70A RF/IF/VF Marker Adder is recommended for trap alignment. The unit is especially valuable in trap-alignment applications because the marker is added to the response curve *after* the sweep signal is taken out of the receiver, thus eliminating all suckout. If a marker adder is not used, the WR-99A should be set for maximum output and the scope gain set to maximum to increase the size of the marker. If difficulty is experienced, more precise adjustment may be achieved by connecting a Volt-Ohmyst, set for dc-voltage measurements, across the second-detector load resistor, and tuning the trap for minimum voltage reading on the meter.

The general procedure in aligning picture-if amplifiers is first to set the traps and then to align the amplifier circuits. Since any adjustment of the amplifier circuits usually will slightly detune the traps, the traps may have to be "touched up" during the picture-if amplifier alignment. The manufacturer's alignment instructions will again determine the exact procedure to follow.

Alignment of Sound-IF Amplifiers and FM Detectors

A typical test set-up for aligning an intercarrier-type sound-if amplifier is shown in Figure 9. This system employs a ratio detector which receives its signal directly from the last sound-if amplifier stage. Circuits which use a discriminator detector will employ a limiter stage ahead of the detector circuit.

An over-all response curve of the sound-if amplifier and detector is obtained by connecting the sweep generator and the WR-99A at point "A", the grid of the first sound-if amplifier. Set the CAL/MOD control on the WR-99A to "4.5 MC". The oscilloscope is connected at point "C", where a demodulated signal appears. The sweep width control on the sweep generator should be set to give a sweep width of approximately 1 Mc. An "S"-shaped curve, similar to the curve shown in Figure 10, will appear on the oscilloscope screen.

To check alignment of the first if-amplifier stage only, the oscilloscope probe should be moved to point "B" where a sweep response curve similar to that shown in Figure 11 should be obtained. The marker indicates the 4.5-Mc center frequency of the curve. If the marker does not appear exactly at the center of the curve, the amplifier should be adjusted as recommended by the manufacturer until the marker is exactly at the center of the curve. This assures that response is symmetrical and adequate audio bandwidth is obtained.

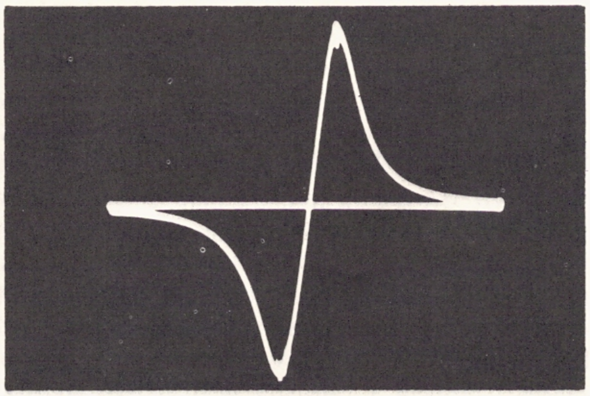


Figure 10. Response curve for fm-sound detector. Symmetrical shape indicates correct alignment.

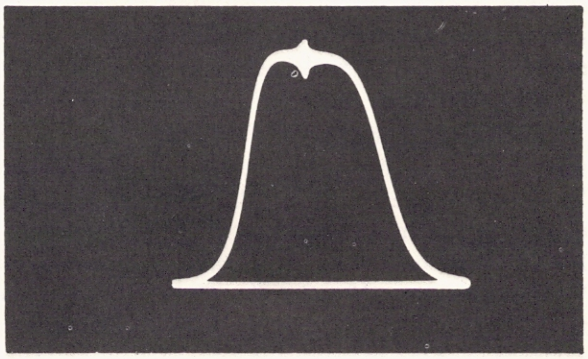


Figure 11. Sound-if response curve. Marker shows center of pass band and is the sound intermediate frequency.

If a discriminator detector is used, the stage will be preceded by a limiter. The over-all response of the if amplifier is checked by connecting the oscilloscope across the resistor in the grid circuit of the limiter. In some receivers, the time constant of the grid circuit may be large enough to cause distortion of the pattern when the scope is connected. If the pattern is distorted, the difficulty may be eliminated by temporarily removing the capacitor from the rf circuit or by shunting the resistor with another resistor of a value determined by experimentation.

The response of the sound-if amplifier alone in a system using a discriminator-type detector may be checked by using the same procedure as for checking an amplifier using a ratio-type detector. Set the CAL/MOD control to "4.5 Mc & 600 CPS". The sound-if point should appear at the intersection of the response curve and the zero-reference line. Tune the detector transformer as indicated in the manufacturer's service notes.

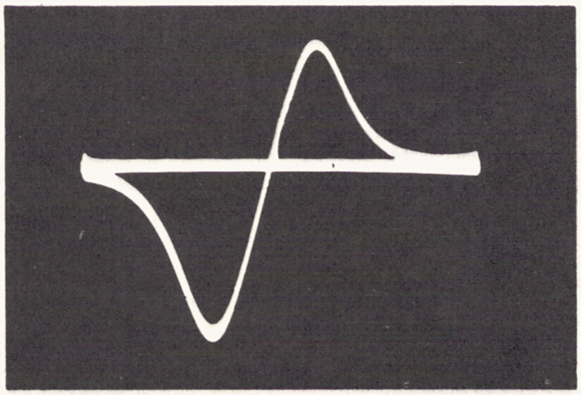


Figure 12. FM-detector curve showing 600-cps modulation. Modulation causes wide trace or waviness on base line. When center frequency of detector is tuned exactly to the sound intermediate frequency, modulation will disappear.

If the detector is not correctly aligned, the 600 cps will modulate the "S" curve, as shown in Figure 12. When the detector is set to exactly 4.5 Mc, the modulation will be cancelled out.

Use of WR-99A as Heterodyne Frequency Meter

The WR-99A may be used with good accuracy to determine the frequency of an external signal between 20 and 260 Mc. In general, the procedure consists of feeding the signal of unknown frequency into the WR-99A, mixing it with the vfo signal from the WR-99A, and, by use of the zero-beat method and interpolation, reading the frequency directly from the WR-99A dial. This feature is particularly useful in checking the oscillator frequency in intercarrier receivers. Procedure is as follows:

1. Connect a lead from the rf output of the external signal source to the RF IN connector.

2. Set the tuning dial of the WR-99A to read the approximate estimated frequency of the external signal.

3. Calibrate the WR-99A at the 1-Mc or 10-Mc check point nearest the frequency of the external signal, as described under "Calibration".

4. If the unknown signal is of very low level, turn the AF GAIN control fully clockwise. It may also be necessary to connect a ground lead from the external signal source to the GND terminal of the WR-99A.

5. Turn the tuning dial of the WR-99A until zero beat is obtained with the external signal.

6. Determine the frequency of zero beat by observing the dial setting and interpolating, as described under "Calibration".

Maintenance

Caution: See "Safety Precautions", Page 2

General

Performance of the WR-99A depends upon the quality of the components employed. If it should be necessary to replace any of the component parts, only RCA replacement parts or equivalents of those shown in the Replacement Parts List of this instruction booklet should be used.

The chassis may be removed from the case by removing two screws from the bottom of the front bezel, removing the bezel by sliding it off the bottom and lifting upward, removing two screws from the back of the case, and removing 14 screws from around the edge of the front panel. Pull the panel and chassis out of the case.

If any alignment adjustments are made, the line voltage should be 117 volts, at 60 cps. If trouble is encountered, voltage readings should be taken and compared with the operating voltages shown on the schematic diagram. Conventional trouble-shooting techniques should be used to locate trouble.

Circuit Description and Operation

The WR-99A is built around a Colpitts-type variable-frequency oscillator (V1) which utilizes an RCA-6AF4-A. (See Figure 13). This oscillator is tunable by means of capacitor sections C1A, C1B, C1C, and C1D over a band of frequencies from 20 to 260 Mc. This band is divided into eight overlapping rf ranges. On ranges 1 through 5, capacitor sections C1C and C1D and sections C1A and C1B are paralleled. On ranges 6, 7, and 8, only sections C1B and C1C are used.

Output from V1 is taken from the grid and fed to the grid of the modulator stage, V2. Any internal or external modulation is mixed with the rf signal in this stage. Output from the V2 modulator stage is fed through capacitor C6 to the attenuator network.

Internal crystal-controlled calibrating markers are generated by a Miller-type crystal oscillator stage, V4A, which generates 10-Mc harmonic signals. One-megacycle calibrating markers are generated by a 1-Mc Colpitts oscillator, V4B, which is locked to the V4A oscillator in a 10-to-1 ratio. These oscillators may be switched out of operation from the front panel.

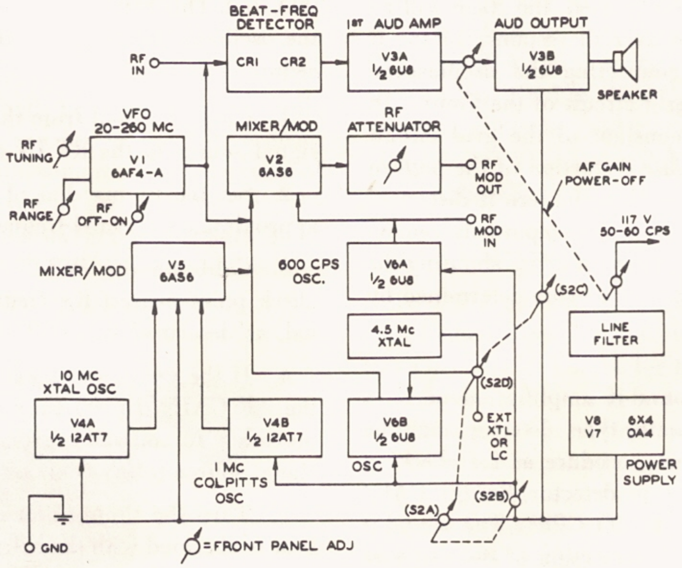


Figure 13. Block diagram of WR-99A.

The 10- and 1-Mc signals from V4A and V4B are fed to the mixer/modulator stage, V5, which mixes the two signals and feeds them through C13 and C5 to grid No. 1 of V2. The output from V5 also contains harmonics of the two signals. The 4.5-Mc signal is generated by V6B, a Pierce oscillator. The 4.5-Mc is fed through C37 to grid No. 3 of V2. The 600-cps modulating signal is generated by a phase-shift oscillator, V6A, which feeds the signal to grid No. 3 of V2. Any signal fed into the MOD IN terminal is also fed to grid No. 3 of V2.

Crystal diodes CR1 and CR2 comprise a voltage-doubler beat-frequency detector. In this circuit, the 1-Mc, 10-Mc, or external signals are beat with the vfo signal from V1 to produce an audio-beat signal from the speaker. V3A and V3B are audio-frequency amplifiers.

Regulation of the B+ voltage for the vfo stage, V1, is accomplished by use of 0A2 regulator tube, V7.

10-Mc Crystal-Oscillator Adjustment

1. Connect the WR-99A to a 1- and 10-Mc standard oscillator, as shown in Figure 15. A Measurements model 111 or equivalent unit may be used as the standard.

2. Set the RF control on the WR-99A to "OFF". Set the CAL/MOD control to "10 MC CAL". Turn the AF GAIN control about three-quarters turn clockwise. Set the standard oscillator to deliver a 10-Mc output signal.

3. With an insulated alignment tool, turn the slug in inductor L9 until about one-quarter inch protudes from the coil form. (See Figure 14 for locations of internal adjustments.)

4. Screw the core slowly back into the coil form and listen for an audio beat between the two 10-Mc signals. Continue screwing in the core until the beat note disappears; then, back the core out of the form one full turn. Switch the CAL/MOD control between "10 MC CAL" and "OFF" several times to make sure that the WR-99A 10-Mc oscillator starts promptly. If oscillator starts erratically, back out the core until oscillation is satisfactory.

5. Adjust trimmer capacitor C24 to zero beat the two 10-Mc signals as closely as possible.

1-Mc Oscillator Adjustment

1. With power applied to the WR-99A, set the RF control to "ON". Set the RF RANGE switch to band 2 (27-30 Mc).

2. Set the CAL/MOD control to "10 MC CAL" and set the RF TUNING to read 30 Mc on the dial scale. With an insulated alignment tool, adjust the core of L2 to zero beat with the third harmonic of the 10-Mc crystal oscillator. Check the zero-beat accuracy at the 40-Mc point. Readjust L2, if necessary.

3. Set the RF control to "OFF" and turn the CAL/MOD control to "1 MC CAL". With the core of L10 set approximately flush with the top of the coil form, adjust the core until a point of lock-in is heard between the 10- and 1-Mc oscillators.

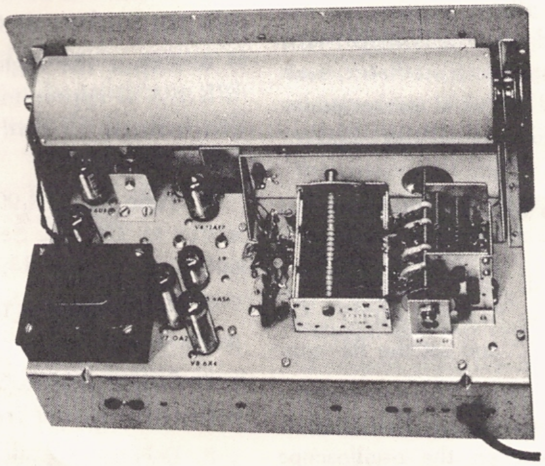


Figure 14. Locations of tubes and internal adjustments in WR-99A.

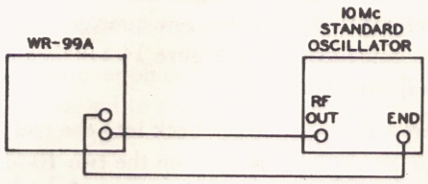


Figure 15. Test setup for alignment of 10-Mc oscillator.

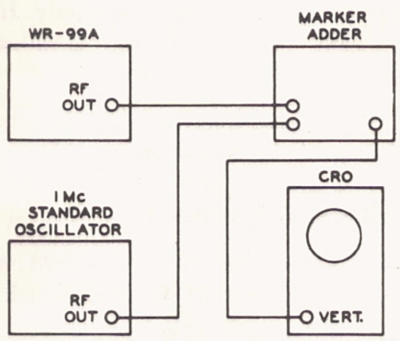


Figure 16. Test setup for alignment of 1-Mc oscillator.

4. Set the RF control to "ON" and carefully check between the 30- and 40-Mc points for a strong beat at each 1-Mc dial mark. If the check points are at other than 1-Mc intervals, adjust L10 to the next lock-in point, higher or lower as required, to give the required sub-multiple of 10 Mc.

5. Adjust the core of L10 and observe the adjustment range over which correct lock-in occurs. Reset the core to the center of the lock-in range.

4.5-Mc Oscillator Adjustment

Alignment of the 4.5-Mc oscillator requires, in addition to the WR-99A, a cathode-ray oscilloscope, such as the RCA WO-91A, a 1-Mc standard oscillator, such as the Measurements model 111, and a marker-adder unit, such as the RCA WR-70A RF/IF/VF Marker Adder.

1. Connect the equipment as shown in the test setup of figure 16.

2. With power applied to all units, set the CAL/MOD control on the WR-99A to "4.5 MC MOD". Set all attenuator switches to "OUT" and set the RF control to "OFF"

3. Adjust the amplitude controls on the market-adder unit to observe the beat on the oscilloscope screen between the second harmonic (9 MC) of the 4.5-Mc oscillator in the WR-99A and the ninth harmonic from the 1-Mc standard oscillator.

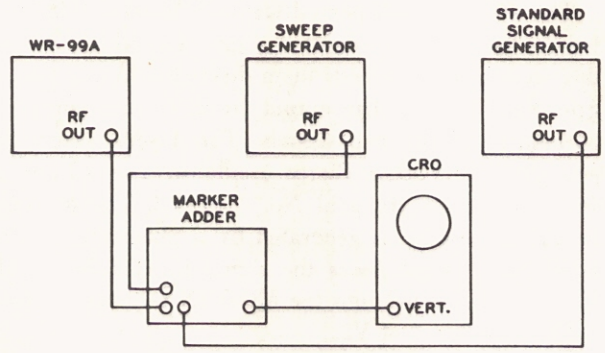


Figure 17. Test setup for vfo tracking adjustments.

4. Adjust trimmer capacitor C41 to obtain as close zero beat as possible.

VFO Tracking Adjustments

NOTE: All vfo adjustments must be made in the order listed.

Band 7 Adjustments. Alignment of the variable-frequency oscillator requires, in addition to the WR-99A, a sweep generator, such as the RCA WR-69A or a WR-59-series unit, a marker-adder, such as the RCA WR-70A RF/IF/VF Marker-Adder, an oscilloscope such as the RCA WO-91A, and a standard signal generator which can deliver output in the vhf region, such as a Measurements model 80.

1. Connect the instruments as shown in the test setup of Figure 17.

2. Set the RF RANGE control to band 7 (170 to 220 Mc).

3. Adjust the sweep generator to deliver output on channel 8. Set the standard signal generator and the WR-99A to deliver output at 170 Mc. Adjust the controls on the marker-adder and the oscilloscope to obtain two markers on the oscilloscope sweep trace.

4. Adjust the high-frequency trimmer, C2, in the WR-99A to approximately the center of its range. Adjust inductor L7 until the two markers coincide on the trace.

5. Tune the WR-99A and the standard signal generator to 220 Mc. Set the sweep generator to deliver output on channel 13.

6. Readjust C2 in the WR-99A to again coincide the markers on the scope trace.

7. Repeat steps 4, 5, and 6, as necessary, until both ends of the band-7 frequencies track correctly.

8. Decrease the output from the standard signal generator and the sweep generator. Set the CAL/MOD control to "10 MC CAL". Recheck tracking at the 10-Mc points on band 7 and readjust, if necessary.

Band 4 Adjustments — The test setups and techniques for alignment of band 4 are the same as described above, except as follows:

1. Set the sweep generator to deliver output on channel 2; adjust the standard signal generator and the WR-99A to deliver output at 50 Mc.

2. Adjust trimmer C21 to approximately center range; adjust inductor L4 to coincide the two markers on the oscilloscope trace.

3. Tune the standard generator and the WR-99A to 90 Mc. Set the sweep generator to deliver output on channel 6. Readjust C21 to again coincide the markers.

4. Repeat steps 2 and 3 until both ends of band 4 track correctly.

5. Recheck tracking at 10-Mc crystal check points and readjust, if necessary.

Band 1 Adjustments — The test setup and techniques for alignment of band 1 are the same as described above except as follows.

1. Tune the standard generator and the WR-99A to 19 Mc. Turn off the sweep generator.

2. Adjust capacitor C48 to approximately one-half capacity and adjust the core of L1 until a beat appears on the oscilloscope trace.

3. Tune the standard generator and the WR-99A to 28 Mc. Adjust C48 for zero beat of the two signals.

4. Repeat the low- and high-end adjustments until both the 20- and 28-Mc points track perfectly.

5. Reduce output from the standard generator. Set the CAL/MOD control to "1 MC CAL" and check the tracking at all 1-Mc calibration points from 19 to 28 Mc. Readjust, if necessary, to obtain correct tracking.

Band 2 Adjustments — Utilize the same procedure described under "Band 1 Adjustments" except align the low-frequency end by means of L2 at 25 Mc. Align the high-frequency end at 40 Mc by means of C50.

Adjustments for Other Bands — Utilize the same procedure described under "Band 1 Adjustments" except as follows:

Band 3 — Adjust L3 at 39 Mc; adjust C52 at 50 Mc.

Band 5 — Adjust L5 at 80 Mc only.

Band 6 — Adjust L6 at 140 Mc only.

Band 8 — Adjust L7 at 210 Mc only.

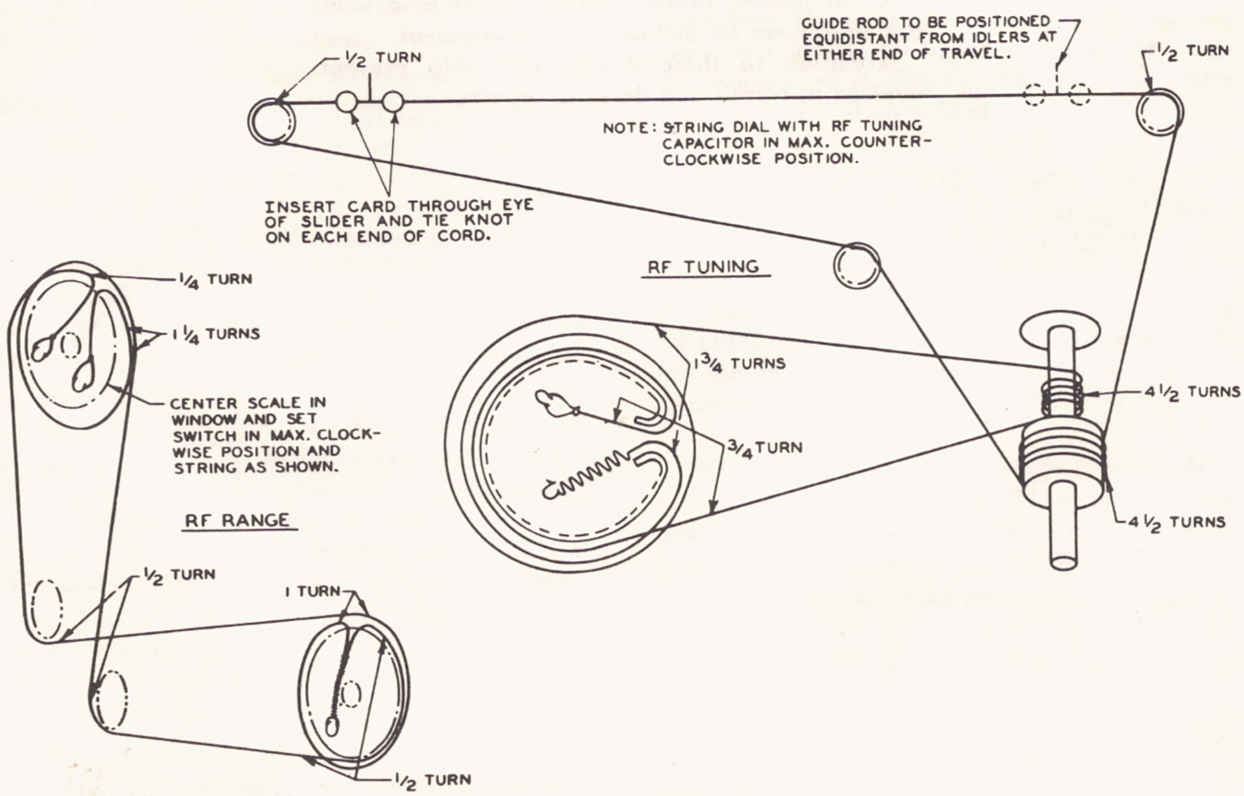


Figure 18. Dial-Stringing arrangement in WR-99A.

RCA Repair Service

RCA maintains a complete repair service for the adjustment, calibration, and maintenance of RCA test equipment. If it becomes necessary to service this equipment, the report forms enclosed in this booklet should be filled out as described. It is important that:

1. Test equipment be packed carefully.
2. A full description of the trouble be included in the report.
3. All probes, cables, and test leads used with the equipment be included in the shipment.

Attention to these details will help prevent damage in transit and delay in repairs.

RCA

WARRANTY

Factory-Wired Equipment

Radio Corporation of America, hereinafter referred to as "RCA," warrants to the original retail purchaser of this instrument that it will furnish a replacement part (including tubes but excluding batteries) or, at its option, repair any part thereof which proves upon inspection by RCA to have been defective within one year from the date of original retail sale by the RCA Distributor, if it was used thereafter solely within the United States of America, in accordance with the terms of this warranty.

This warranty does not apply to any part or parts of this instrument if it has been installed, broken, altered, repaired or misused through negligence or otherwise in a way that in the opinion of RCA affects the reliability of or detracts from the performance of any part or parts of the instrument, or if its serial number or the serial number of any such part or parts has been altered, defaced or removed, nor does this warranty cover replacement or repairs necessitated by loss or damage resulting from any cause beyond the control of RCA, including but not limited to Acts of God, acts of government, floods, fires, shortage of materials, and labor difficulties.

Within one year from such purchase, any such defects must be brought to the attention of RCA or an Authorized RCA Test Equipment Service Depot. If upon examination by RCA or an Authorized RCA Test Equipment Service Depot, the part is found to have been defective within the applicable warranty period, RCA will, at its option, furnish the purchaser with a new or rebuilt replacement part, or return the defective part repaired.

The obligation of RCA under this warranty is limited to making a new or RCA rebuilt replacement part, or subassembly available to the purchaser, or repairing the defective part, or subassembly, and does not include the furnishing of any labor involved or connected therewith, such as that required to diagnose the necessity for replacement or repairs, or to remove or install any such parts; nor does it include responsibility for any transportation expenses nor any damages or losses incurred in transportation in connection therewith, nor any consequential damages of any nature.

The foregoing is in lieu of all other warranties, express, implied or statutory, and RCA neither assumes nor authorizes any person to assume for it any other obligation or liability in connection with the sale or use of this instrument.

The facilities of RCA and its Authorized Test Equipment Service Depots are available at a nominal labor charge for the repair and calibration of RCA Test Equipment.

Kits

Radio Corporation of America, hereinafter referred to as "RCA," warrants to the original retail purchaser of this kit that it will furnish a replacement part (including tubes but excluding batteries) or, at its option, repair any part thereof which proves upon inspection by RCA to have been defective within ninety days from the date of original retail sale by the RCA Distributor, if it was used thereafter solely within the United States of America, in accordance with the terms of this warranty.

This warranty shall not apply to any part or parts of this kit if it has been installed, broken, altered, repaired or misused through negligence or otherwise in a way that in the opinion of RCA affects the reliability of or detracts from the performance of any part or parts of the kit, or if its serial number or the serial number of any such part or parts has been altered, defaced or removed, nor does this warranty cover replacements or repairs necessitated by loss or damage resulting from any cause beyond the control of RCA, including but not limited to Acts of God, acts of government, floods, fires, shortage of materials, and labor difficulties.

Within ninety days from such purchase, any such defects must be brought to the attention of RCA or an Authorized RCA Test Equipment Service Depot. If upon examination by RCA or an Authorized RCA Test Equipment Service Depot, the part is found to have been defective within the applicable warranty period, RCA will, at its option, furnish the purchaser with a new or rebuilt replacement part, or return the defective part repaired.

The obligation of RCA under this warranty is limited to making a new or RCA rebuilt replacement part, or subassembly available to the purchaser, or the repair of a defective part, or subassembly, and does not include the furnishing of any labor involved or connected therewith, such as that required to diagnose the necessity for replacement or repair, or to remove or install any such parts; nor does it include responsibility for any transportation expenses nor any damages or losses incurred in transportation in connection therewith, nor any consequential damage of any nature.

RCA shall not be liable for any anticipated profits, consequential damages, loss of time or other losses incurred by the buyer in connection with the purchase, assembly or operation of RCA Test Equipment Kits or components thereof.

This warranty is completely voided if acid-core solder or paste fluxes have been used in the wiring. RCA will not replace, repair, or service any kits thus mishandled.

The foregoing is in lieu of all other warranties, express, implied or statutory, and RCA neither assumes nor authorizes any person to assume for it any other obligation or liability in connection with the sales or use of this instrument.

The facilities of RCA and its Authorized Test Equipment Service Depots are available at a nominal labor charge for the repair and calibration of RCA Test Equipment Kits which have been completely assembled in accordance with RCA's assembly instructions.

Description of Trouble (Continued)

RCA Electronic Instrument Service Order

Authorized RCA Electronic Instrument Service Depots throughout the United States are available for repair and calibration of RCA factory-wired equipment. For up-to-date listings of these Authorized Depots contact your RCA Distributor or write to RADIO CORPORATION OF AMERICA, Electronic Components and Devices, Electronic Instruments, 415 South 5th Street, Harrison, New Jersey.

DO NOT SEND EQUIPMENT TO RCA

When returning a wired unit or assembled kit to the Service Depot for repair, fill in this form as completely as possible, and enclose it with the instrument.

Owner's Name ______________________________

Street and No. ______________________________

City and State ______________________________

Instrument Type No. ____________________ Serial No. ____________________

(Sales slip or proof of purchase must be supplied if warranty is claimed.) See reverse side for terms of warranty on both kits and wired instruments.

Purchased from ______________________________

Street and No. ______________________________

City and State ______________________________

Date of Purchase ____________________ Sales Slip No. ____________________

Was Warranty Registration card mailed to RCA at time of purchase? ____________________

If instrument is out of warranty, request Service Depot . . . (indicate your choice below):

☐ *Repair and return* ☐ *Quote cost before repairing*

Description of trouble. (Be specific. Use reverse side of form if more space is needed. State what repairs you wish made.)

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RCA Electronic Instrument Kits

NOTE: Any defective component in an RCA Test Equipment kit can be replaced free-of-charge by writing to RCA, Electronic Components and Devices, Electronic Instruments, 415 South 5th Street, Harrison, New Jersey. If help is needed in troubleshooting, calibrating, or repairing an assembled kit, the facilities of the RCA Test Equipment Repair Depots may be used. An estimate may be requested for the labor charges and any charges for replacement of components which may have been damaged during assembly or operation.

RCA will supply the necessary material at no charge for in-warranty repair of kits. Most Service Depots have a minimum charge of $5.00 for handling, troubleshooting, cost estimating, and calibration.

DO NOT SEND PARTIALLY ASSEMBLED KITS TO SERVICE DEPOTS

IMPORTANT!

Damage incurred in shipment will be the owner's responsibility if the instrument is not properly packed. Observe the following precautions:

1. Carefully pack instrument in an oversize extra-heavy corrugated carton. Float the instrument in at least 3 inches of excelsior or wadded paper.
2. Enclose all test leads and probes with instrument. Individually wrap each of these accessories.
3. Ship instrument by Parcel Post or Railway Express prepaid. Insure shipment for its full replacement value.

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES
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EI Form 120 (3) 11-65

(SEE OTHER SIDE)