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# **SINGLE SIDEBAND CONVERTER CV-157/URR**

**(FIELD MAINTENANCE)  
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DEPARTMENTS OF THE ARMY AND  
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SINGLE SIDE BAND CONVERTER CV-157/URR

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# CHAPTER 1

## INTRODUCTION

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### Section I. GENERAL

#### 1. Scope

*a.* This manual contains information on the maintenance, alinement procedures, troubleshooting, and repair of Single Sideband Converter CV-157/URR (fig. 1). Throughout this manual, Single Sideband Converter CV-157/URR will frequently be called the converter.

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

#### 2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of army materiel and equipment and when performing preventive maintenance.

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

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

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

*d.* Use other forms and records as authorized.

### Section II. DESCRIPTION AND DATA

#### 3. Purpose

*a.* Single Sideband Converter CV-157/URR (fig. 1) is primarily intended to function as a link at the receiving end of a radio communication system using single-sideband or twin single-sideband reduced carrier emission. The converter, using the intermediate-frequency (if.) output of a communication receiver, separates the transmitted carrier frequency from its sideband frequencies and demodulates the audio intelligence present in the sidebands.

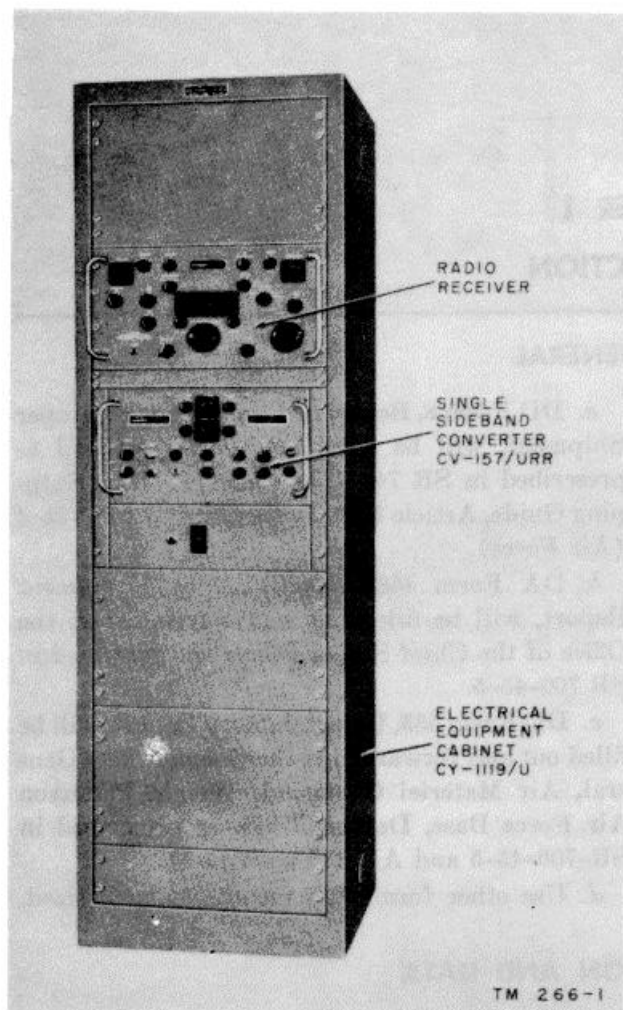
*b.* The converter is used also as an aid in the reception of amplitude-modulated (am.) double-sideband signals under conditions of extreme atmospheric interference.

#### 4. System Application

(fig. 2)

*a.* The converter is intended for use in applications between fixed installations having a heavy flow of message traffic. The output signal of the converter will be identical with the multiplexed signals delivered over the

wires in voice-frequency land line carrier telephone. Thus, the converter, operating with a radio receiver, may be used to feed carrier terminal equipment that operates several channels of teletypewriter, facsimile, or voice reproducing equipment. Each of the two converter output channels corresponds to a pair of wires in landline voice-frequency multiplexing operations. When receiving a single-sideband signal, the converter will deliver an output from a single channel that may be used to operate as many channels of teletypewriter, facsimile, or voice reproduction equipment as could be operated from a corresponding pair of wires that carry a .1- to 6-kilocycle (kc) energy spectrum and feed a single carrier terminal equipment. When twin-single side-band emission is being used, the converter will deliver two separate channels of output, thus doubling the amount of intelligence that would be received with a single-sideband signal. With twin



**Figure 1. Single Sideband Converter CV-157/URR in operating position.**

single-sideband reception, it is possible to have one channel used for one kind of intelligence, while the second channel is used for another kind of intelligence. Thus, a multiplexed teletypewriter signal can be delivered from one converter channel, while the second channel handles voice intelligence and a facsimile circuit.

b. Figure 2 illustrates a typical system that uses Single Sideband Converter CV-157/URR. A twin single-sideband signal is transmitted having eight channels of teletypewriter intelligence in one sideband and voice intelligence in the other sideband. A reduced carrier has been included as a control signal. The transmitted signal may lie within the range of the receiver which, in the case of Radio Receiver R-390/URR (the intended companion receiver for this converter) is .5 to 32 megacycles (mc).

The converter is used with Radio Sets AN/FRR-40 and AN/FRR-41. Refer to the manual on Radio Sets AN/FRR-40 and AN/FRR-41 for operation of the converter.

## 5. Technical Characteristics

### Frequency data:

Input frequency with 455 kc.  
converter aligned as  
supplied.

Heterodyne oscillator Input frequency plus 100 kc.  
frequency.

Input frequency range with 450-510 kc.  
minor readjustments.

Converter if center (local 100 kc carrier oscillator)  
frequency. 100 kc.

Carrier filter band pass 100 kc  $\pm$  10 cps.

Converter upper sideband 100.1 to 106 kc.  
filter band pass.

Converter lower sideband 94 to 99.9 kc.  
filter band pass.

Audio-output frequency  
range (both output  
channels):-

With LOWPASS FILTER in 125 cps to 6 kc.  
the OUT POSITION.

With LOW PASS FILTER 125 cps to 3.5 kc,  
in the IN position.

Power source required 105-125 volts ac, 50-60  
cycles, single-phase or  
210-250 volts ac, 50-60  
cycles, single-phase.

Number of tubes 44.

Number of input channels 1.

Number of output channels 2.

Output data Audio-output frequency  
available at terminal-  
board TB1 located on  
rear of chassis.

Monitoring facilities Available at MONITOR jack  
located on front panel.

Power consumption 250 watts.

Weight Approx 104 lb.

Audio-output level (channels Variable between 0-100  
A and B). milliwatts with 5,000  
microvolts or more input  
from receiver if.

Type of frequency control Automatic frequency control  
based on phase  
comparison. Motor  
operation of heterodyne  
oscillator tank tuning.

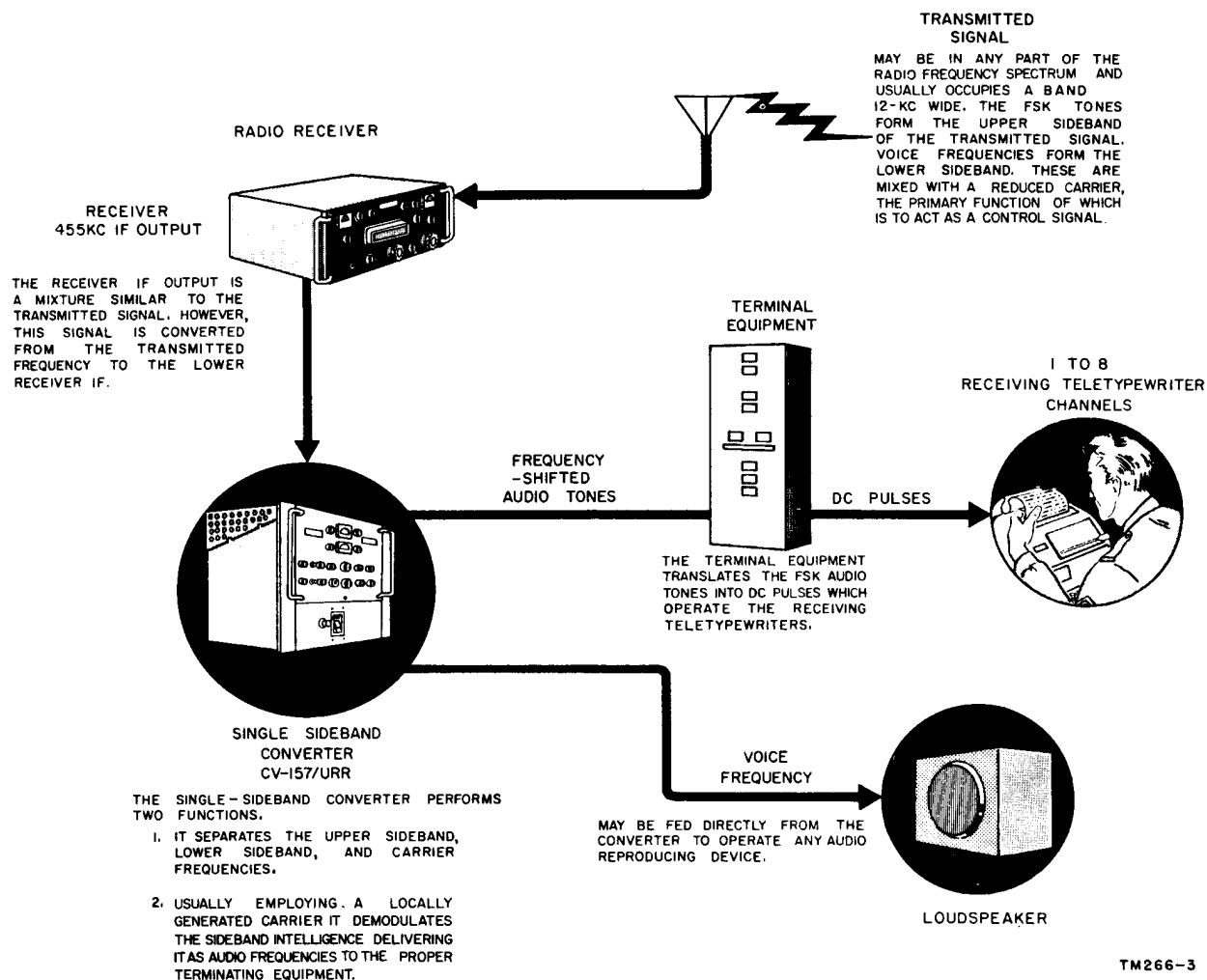


Figure 2. Converter, system application.

## Frequency data-Continued

Automatic gain control .... Selectable by the operator, to be actuated by the signal element (upper side band, lower side-band, twin sideband, receiver, and carrier) as desired. Age voltage is applied from the converter to control the gain in the receiver.

### Alarms:

SQUELCH ALARM.... Operates when signal-to noise ratio falls below a predetermined level.

DRIFT ALARM ..... Actuated just before afc circuit has reached the end of its useful corrective range.

## 6. Description

a. Single Sideband Converter CV-157/URR ( fig. 3) is a self-contained unit used for fixed installation in any standard 19-inch relay rack.

b. The converter is divided into a base assembly and a drawer assembly. The drawer assembly contains most of the critical components of the converter. It can be extended from the base assembly on drawer slides of the filing cabinet type so that much of the testing can be accomplished without removing the unit from its place of installation (C, fig. 44).

c. All input and output connections, except for the monitoring facilities, are made at the rear panel of the converter. The MONITOR jack is located on the front panel. All interconnecting cables may remain in place when the drawer as-

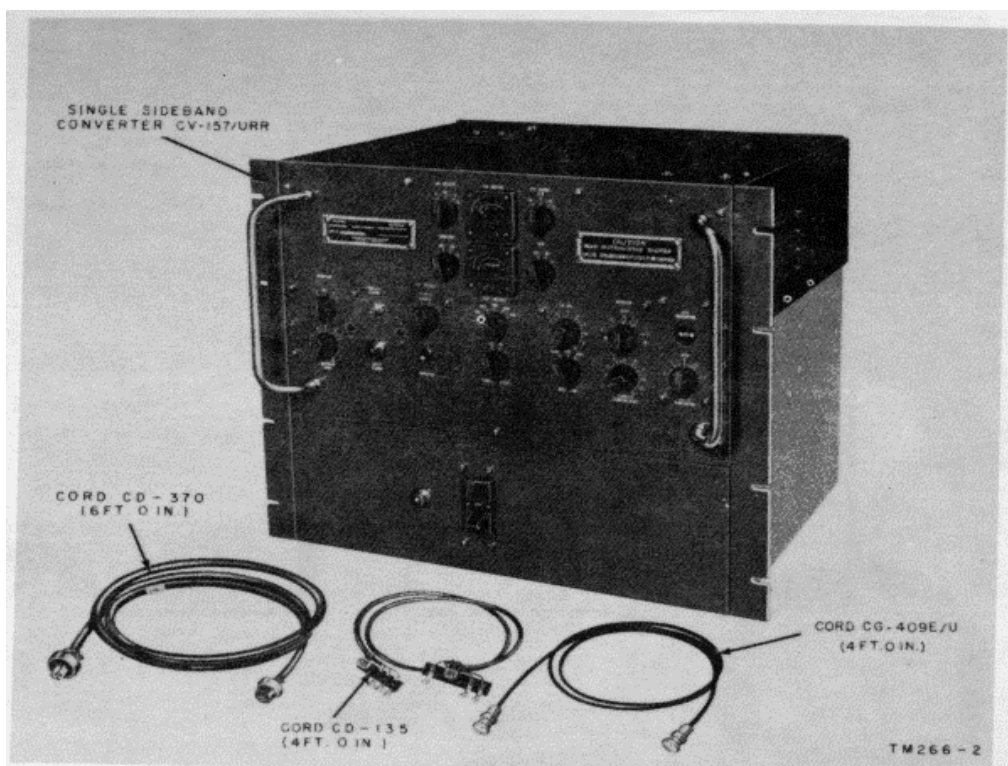


Figure 3. Converter, operating components.

sembly of the converter is extended for servicing.

d. All operating controls and meters are located on the front panel. When the drawer assembly is extended on its slides, the adjustment controls of the converter used for alinement are easily accessible. Power supply adjustments for varying input voltages also may be made when the drawer assembly is extended. The power switch of the converter is coupled to a circuit breaker, making the use of fuses unnecessary.

## 7. Controls and Instruments

a. *Operating Controls* (figs. 4 and 5). The following chart lists the operating controls of the converter and indicates their functions:

Control	Function
Power switch .....	In ON position, applies both plate and filament voltages to the equipment. It is a circuit breaker that serves as a protective device by automatically tripping to OFF position whenever faulty circuits or components cause excessive current drain from the power source.

Control	Function
MONITOR SWITCH.....	In A position, selects the audio intelligence in channel A to be monitored; in B position, selects the audio intelligence in channel B to be monitored.
MONITOR GAIN control	Varies the volume of the monitored signal.
A-VC (channel A volume control).	Varies the audio level of channel A output
B-VC (channel B volume control).	Varies the audio level of channel B output.
SB SELECT switch (sideband select switch).	In counterclockwise (A-LSB B-USB) position, the intelligence contained in the transmitted lower sideband is fed to channel A output, and the intelligence contained in the transmitted upper sideband is fed to channel B output (fig. 6). In clockwise (LSB-B, USB-A) position, the intelligence contained in the transmitted lower sideband is fed to channel B output, and the intelligence contained in the transmitted upper sideband is fed to channel A output (fig. 6)

Control	Function
VU SELECT switch	In A position, selects channel A audio-output level to be measured by the VU METER; in B position, selects channel B audio output to be measured by the VU METER.
VU RANGE switch	Changes the range of the VU METER
SQUELCH switch	Turns squelch ON and OFF.
AFC switch	Turns automatic frequency control circuit ON and OFF.
AGC SELECT switch (automatic gain control switch)	In REC (receiver) position the associated receiver uses its own agc voltage, and the select converter has no control of receiver radio-frequency (rf) gain. In the CAR (carrier) position the 100-kc converted carrier, with the modulation removed, is selected as the source of automatic gain control (agc), voltage developed by the converter to control the rf gain of the associated receiver. In the LSB (lower sideband) position, the intelligence contained in the transmitted lower sideband is selected as the source of age voltage developed by the converter to control the rf gain of the associated receiver. In USB (upper sideband) position, the intelligence contained in the transmitted upper sideband is selected as the source of age voltage developed by the converter to control the rf gain of the associated receiver. In TSB (twin sideband) position, the 100-kc converted carrier, plus the sidebands are selected as the source of agc voltage developed by the converter to control the rf gain of the associated receiver
CARRIER SELECT	In LC position, selects the output of the local carrier switch oscillator to demodulate the intelligence present in the sideband frequencies In RC position, selects the reconditioned carrier to demodulate the intelligence present in the sideband frequencies.

Control	Function
SB AGC control	Varies the amount of agc voltage developed by the converter when the AGC SELECT switch is in TSB, USB, or LSB position
AGC TIME switch	Varies the time constant of the agc voltage developed by the converter.
VERNIER control	Tunes the converter heterodyne oscillator over a range of $\pm 2$ kc.
LOWPASS FILTER switch	In IN position, limits the converter audio-output frequency band pass to 3.5 kc In OUT position, allows frequencies as high as 6 kc to pass. This switch controls the bandwidth of both channels simultaneously.
RANGE COMPENSATOR control	Adjustment of this control corrects the calibration of the VERNIER and the DRIFT INDICATOR controls to insure that the markings on each are accurate within 200 cycles per second (cps). Refer to figure 51 for approximate setting.
CARRIER COMPENSATOR control	Varies the gain of the converter carrier section to adjust for various levels of carrier suppression at the transmitter (fig. 53).
VOLTAGE SELECT	In 115V position, it selects the low-voltage primary of the power input transformer for operation from the power source and the high amperage winding of circuit breaker CB1. In 230V position, it selects the high- voltage primary of the power input transformer for operation from the power source and the low amperage winding of circuit breaker CB1.

*Note.* Front panel markings apply to the transmitted sidebands when the converter is used with Radio Receiver R-390/URR or a receiver having the same conversion sequence.

*b. Indicating Instruments.* The following chart lists the indicating instruments on the front panel of the converter (fig. 4) and indicates their functions:

Indicator	Function	Indicator	Function
SQUELCH ALARM	Operates only when the SQUELCH switch is in ON position. Lights when the automatic frequency control (afc) circuit has been disabled because the signal-to-noise ratio is too low for correct operation.	DRIFT INDICATOR	With the AFC switch in ON position, it automatically indicates the amount of system frequency drift. With the AFC switch in OFF position, it may be used manually to tune the converter heterodyne oscillator over a range of $\pm 2$ kc.
DRIFT ALARM	Indicates that the frequency is off approximately $\pm 2$ kc. Lights when the DRIFT INDICATOR is near either end of its range.	VU METER	With the VU SELECT switch in the A position, it indicates channel A audio-output level from the converter. With the VU SELECT switch in the B position it indicates channel B audio-output level from the converter.
AFC INDICATOR	Mechanically linked to the afc motor (B1). With the AFC switch in ON position, it moves to give visual indication of the afc motor operation.	CARRIER LEVEL meter	Indicates the level of the reconditioned carrier, as adjusted by the CARRIER COMPENSATOR control.
DRIFT INDICATOR	Mechanically linked to the afc motor (B1).	Pilot lamp	Lights when the power switch is in the ON position.

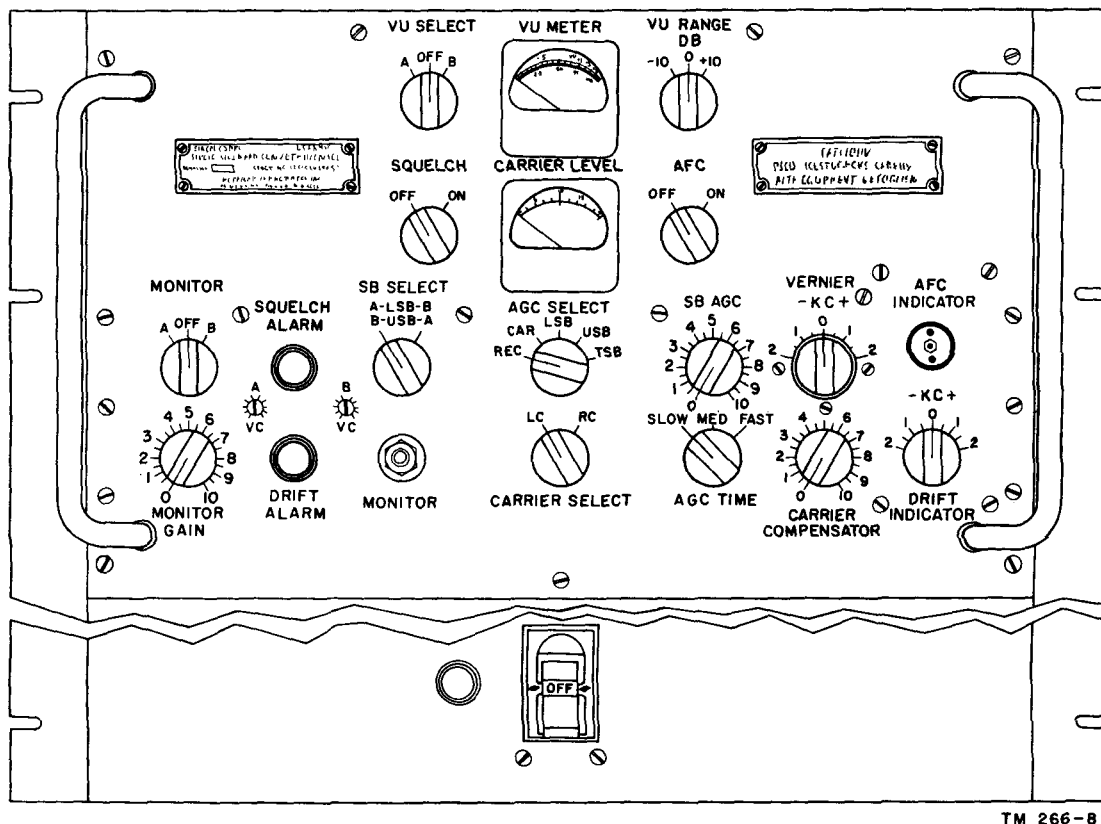
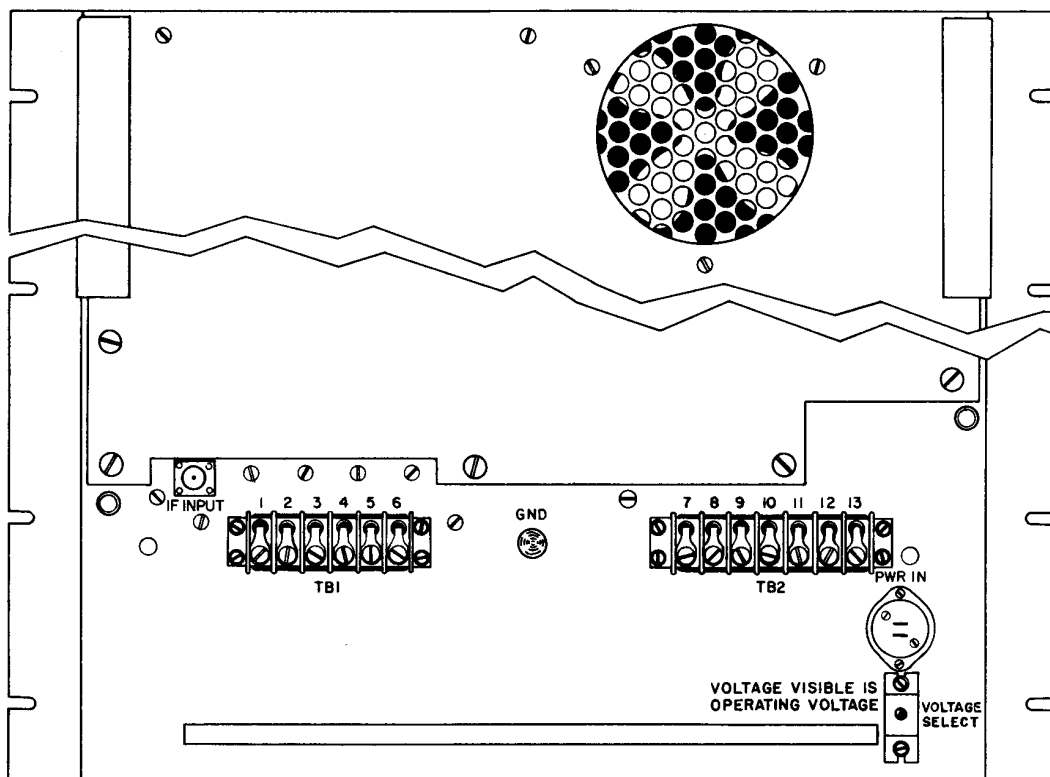


Figure 4. Converter, front panel.





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Figure 5. Converter, rear view.

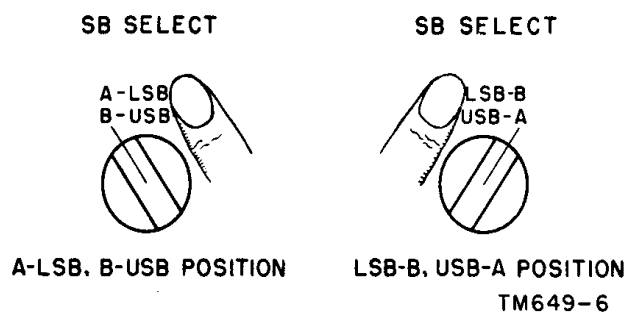


Figure 6. Positions of SB SELECT switch.



## CHAPTER 2

### THEORY

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#### 8. Block Diagram

a. *General.* In the block diagram (fig. 7), the following circuits have been included in Single Sideband Converter CV-157/URR.

- (1) *Monitor circuits.* A VU METER and a monitor audio-output circuit are included in the converter to facilitate audio-output level adjustments and tuning operations.
- (2) *Afc circuit.* This circuit controls the frequency of the converter heterodyne oscillator and holds the converter if. at exactly 100 kc. This compensates for frequency drifts in the receiver, transmitter, and converter. This circuit assures an extremely accurate audio-frequency (af) output from the converter.
- (3) *Squelch circuit.* The squelch circuit automatically disables the afc circuit when the signal-to-noise ratio of the converter input signal drops below a certain preselected level. The squelch circuit prevents the afc circuit from being actuated by noise instead of signal, which would result in the converter being detuned.
- (4) *Local carrier oscillator.* This circuit provides a constant amplitude, noise-free carrier frequency for use in the converter demodulators. It also provides a frequency standard against which the incoming carrier is compared for operating the afc circuit.
- (5) *Agc circuit.* This circuit enables the converter operator to control the receiver gain from any of the separated signal elements in the converter. Through proper use of the agc circuit, the operator is assured a constant amplitude for that part of the signal in which the amplitude is most critical.

b. *Input Circuit.* The output of the receiver if. amplifier is applied at J1 of the converter and mixed in V1 with the output of the converter heterodyne oscillator, V2. The

output of V2 is 555 kc which, when beat against the 455-kc output of the receiver if., produces a converter if. of 100 kc. The sideband frequencies appear above and below this converted carrier frequency, which is delivered to the first if. amplifier, V3.

c. *Sideband If. Amplifier and Filter Circuits.* The output of V3 is delivered to three additional if. amplifiers, two of which (V4 and V11) are used to amplify the signal further for delivery to the converter upper and lower sideband filters, FL1 and FL3. Filter FL1 separates the *converter* upper sideband frequency elements from the if. signal output of V4, which because of sideband inversion, were originally the *transmitted* lower sideband frequency elements. The sideband filters are selective and the frequencies above and below the sideband elements are sharply attenuated. The converter lower sideband filter, FL3, functions similarly to FL1, separating the *converter* lower sideband frequency elements from the if. signal that is fed to it from amplifier V11.

d. *SB SELECT Switch and Sideband Amplifiers.* The outputs of the two sideband filters are delivered to SB SELECT switch S1. The operator selects the converter audio-output channel that will deliver the intelligence in the converter upper sideband and the channel that delivers the intelligence in the converter lower sideband. The switch selects the output of each of the sideband filters to be fed to the channel A or channel B. sideband amplifier. The switch is marked so that the output of the converter *lower* sideband is delivered through channel B. in the A-LSB, B-USB position of S1. This is because the markings on the switch refer to the sidebands of the *transmitted* signal when the signal is received in Radio Receiver R-390/URR or any other receiver having a similar conversion sequence. Where the transmitted side-bands are inverted as a result of heterodyning in some other type of receiver, the markings of the SB SELECT switch no longer apply to the sidebands of the transmitted signal. From the SB SELECT switch, the signals are fed to channel A sideband amplifier V5A

and channel B sideband amplifier V12A, where the signal strength is further increased preparatory to demodulation.

*e. Channel A Demodulators.* Three triode sections, V5B, V6A, and V6B, are used in the channel A demodulator circuit to serve the dual functions of audio detection and amplification. The sideband frequency output of V5A is delivered to the demodulator stages where it is mixed with the 100-kc output signal of either the third carrier limiter or the local carrier oscillator, depending on the setting of the CARRIER SELECT switch, S6. The resultant mixture consists of many different frequencies, including the sideband frequency minus the carrier frequency which is an audio beat frequency that contains the audio intelligence with which the transmitted signal was originally modulated. This desired information is retained, while rejecting the unwanted mixing products in filter networks passing only the audio frequencies. A resistance capacitance network in each channel attenuates the sum frequencies (above 100 kc). Frequency components around 100 kc are sharply attenuated by a tuned 100-kc trap. A low-filter rejects audio frequencies above 3.5 kc. The operator, through LOWPASS FILTER switch S2, selects either that the 100-kc trap or the low-pass filter be placed in the output circuit of the demodulator. The filter used depends on the character of the transmitted signal. Multiplex teletypewriter signals transmitted, using audio frequency diversity, have a bandwidth of about 6 kc. For this type of signal, S2 is placed in the OUT position so that the 100-kc bypass filter is in the output circuit of the demodulator stages. The demodulators in both channels are identical in circuit and operation.

*f. Audio-inverter and Audio-output Stages.* The output stages of each channel, consisting of V7 and V8 in channel A and V14 and V15 in channel B, provide the inverter-amplifier arrangement necessary to deliver a push-pull audio output from the two channels of the converter.

*g. Carrier If. Amplifier and Filter Circuits.* The output of first if. amplifier V3 is delivered to the carrier and the sideband amplifying strips. Carrier if. amplifier V16 amplifies the if. signal before it is fed to the sharply peaked 100-kc carrier filter, FL5. Filter FL5 removes the sideband frequencies from the if. signal, delivering only 100 kc to first carrier amplifier V17.

*h. Carrier Amplifiers.* Following FL5, two amplifiers, V17 and V18, are used to amplify the 100-kc signal. These amplifiers are needed in the carrier section of the equipment because the normally received signal will have the carrier frequency reduced below the level of the received sideband frequencies.

*i. Carrier Limiter Stages.* The output of the second carrier amplifier is fed to a series of three limiters, V19, V20, and V21, which maintain a constant carrier amplitude by removing the amplitude variations caused by fading. After limiting, the carrier is ready for delivery to the afc circuit and, if necessary, to the demodulator circuits.

*j. AGC SELECT Switch S10.* The converter is equipped with an agc circuit that applies agc voltage to the receiver. This circuit enables a constant amplitude signal to be fed from the converter to the terminal equipment. The receiver agc circuit operates on amplitude of its over-all input signal. Thus, when one sideband is used to transmit voice while the other sideband carries a multiplex teletypewriter signal, the receiver agc circuit is affected by the voice signal. Under these conditions, the receiver agc circuit produces a very erratic output from the converter channel that delivers the demodulated multiplex teletypewriter signal to terminal equipment. Noise and extraneous signals also have an adverse effect on the receiver agc system. For this reason, the converter is provided with a selector switch through which the operator may select the receiver agc system from voltages developed at a variety of points throughout the converter. AGC SELECT switch S10 (fig. 7) is a five-position switch. In the REC position, the converter has no control and the receiver agc system operates as it normally would for the overall signal received. This position is used for tuning and adjustment operations and may also be used when the converter agc circuit fails, but continued operation of the system is necessary. In the CAR position, the receiver agc system is controlled by the output of the 100-kc carrier filter, FL5. This position of the switch is used when receiving a standard am. signal or when only speech information is transmitted in the sidebands. In the USB and LSB positions, the output of the converter lower sideband filter FL3 or the converter upper sideband filter FL1, respectively,

is used to control the receiver age. The converter front panel designations refer to the transmitted sideband relationships when the converter is used with Radio Receiver R-390/URR. Either the LSB or USB position of S10 is used when keyed-tone intelligence is received in one converter channel, as some signal of widely varying amplitude (such as a voice signal) is received in the other channel. In the TSB position, the age control signal is taken off the output of first if. amplifier V3. This position of S10 is used when keyed-tone intelligence (or any intelligence of constant amplitude) is received in both converter channels. This position is superior to the REC position for this type of signal, because the if. strip in the receiver and the tuned outputs of V1 and V3 largely eliminate the adverse effects noise and interfering signals have on the receiver agc system

*k. Agc Output Circuit.* The converter age output circuit consists of two amplifiers V36 and V37A, and a rectifier, V37B. The voltage selected by S10 is amplified in V36 and V37A, rectified to a direct-current (dc) voltage in V37B, and then fed to the receiver

*l. Afc Gate.* Afc gate tube V22 triples the output frequency of the third carrier limiter for delivery to the afc circuit. When biased beyond cutoff by a voltage applied from the squelch circuit, the gate effectively prevents the output of the third limiter from reaching the afc circuit to prevent the circuit being actuated by noise.

*m. Phasing Network and Phase Rectifiers.* The output of afc gate V22 and tripler V35B is fed to phase rectifiers V23 and V24. Rectifier V23 has a phase-shifting network in its plate circuit, which insures that any output from the two rectifiers will be 90° out of phase. In the *on frequency* condition, the outputs of V22 and V35B produce no error outputs voltage from the phase rectifiers. As soon as transmitter, receiver, or converter Frequency drift causes a difference between the outputs of V35B and V22, the rectifiers begin to conduct to produce polarized signal outputs, one from each rectifier, which are 90° out of phase with one another. Afc dc amplifier V25 is a dual triode. Each half amplifies the output of one of the phase rectifiers

*n. Afc Amplifier-inverter and Motor Drive Stages.* The output of V25A is fed to V26A; the output of V25B is fed to V29A. Tubes V26 and V29 are dual triodes, operating push-pull into the motor drive amplifiers, V27 through V31 which are connected across the windings of

motor B1. Tube V26 controls the operation of motor drive stages V27 and V28. Tube V29 controls the operation of motor drive stages V30 and V31. Motor B1 is a drag cup motor that runs when a voltage is applied across one winding which is 90° out of phase with that applied across the other winding. The function of the amplifier-inverter and motor drive stages is to amplify the output of the phase rectifiers to a current and voltage necessary to cause B1 to react to the phase difference existing between the outputs of the rectifiers. The motor controls a variable capacitor located in the tank circuit of the converter heterodyne oscillator (V2) so that the converter if. is again returned to 100 kc. When the correct converter if. is once more restored, there ceases to be an output developed at the phase rectifiers and the afc circuit is returned to a *rest* condition

*o. Squelch Circuit.* Regardless of the elaborate filtering, amplifying, and limiting to which the converted carrier frequency is subjected before it is applied to the afc circuit, it is still possible under extremely unfavorable conditions of reception, for noise to become the dominant output of the carrier strip. This would result in erratic operation of the afc circuit and subsequent loss of a usable converter audio output. To prevent erratic operation of the afc circuit, a squelch circuit is provided to measure automatically the signal-to-noise ratio existing in the carrier strip and to disable the afc circuit when its proper operation is endangered through the introduction of noise into the circuit. Figure 7 shows that rectifiers V32A and V32B are used to feed a mixer which, in turn, feeds an amplifier. Rectifier V32A measures the signal strength delivered through the carrier strip for operating the squelch circuit and as a source of rectified voltage for the operation of the CARRIER LEVEL METER. Rectifier V32A also allows the afc circuit to operate when the strength of any signal (noise, as well as carrier) present at the input of the first limiter is of a certain predetermined level. Noise rectifier V32B operates from a filter located in the plate circuit of second carrier limiter V20. The filter acts as a block to the 100-kc signal component in the limiter strip, but passes any noise present in the output of the second limiter. When the rectifier noise voltage delivered to mixer V33 rises above a certain value, afc gate V22 is cut off through amplifier V34. Through V32A and V32B, excessive noise and in-

adequate signal strength are detected and used to drive the afc gate beyond the cutoff point to prevent the delivery of the third limiter output to the afc circuit.

## 9. Input Stage

(fig. 8)

a. An if. of 455 kc is delivered from the receiver to converter IF. INPUT jack J1. Adjustments are provided so that the converter may be used with any receiver that has an if. output within the range of 450 to 510 kc. In this and the other theory paragraphs that follow, it is assumed that the converter is used with Radio Receiver R-390/URR, or equivalent, which has an if. output of 455 kc.

b. The input signal to the converter is applied across coaxial line terminating resistor R1 and control R2. INPUT GAIN adjustment control R2 enables efficient mixing to take place in V1, when the converter is used with receivers that have various if. output amplitudes.

c. Mixer V1 combines the 455-kc output of the receiver with the 555-kc output of the converter heterodyne oscillator to produce the converter if. of 100 kc. The injection voltage, which is developed across R2, is applied to the second control grid (pin 7) of V1. The output of the converter heterodyne oscillator is coupled through C1 and applied to the first control grid (pin. 2) of V1. The plate circuit of V1 is tuned to select the difference between the mixer 455- and 555-kc inputs, and reject other unwanted frequencies produced in the tube. The plate current of V1

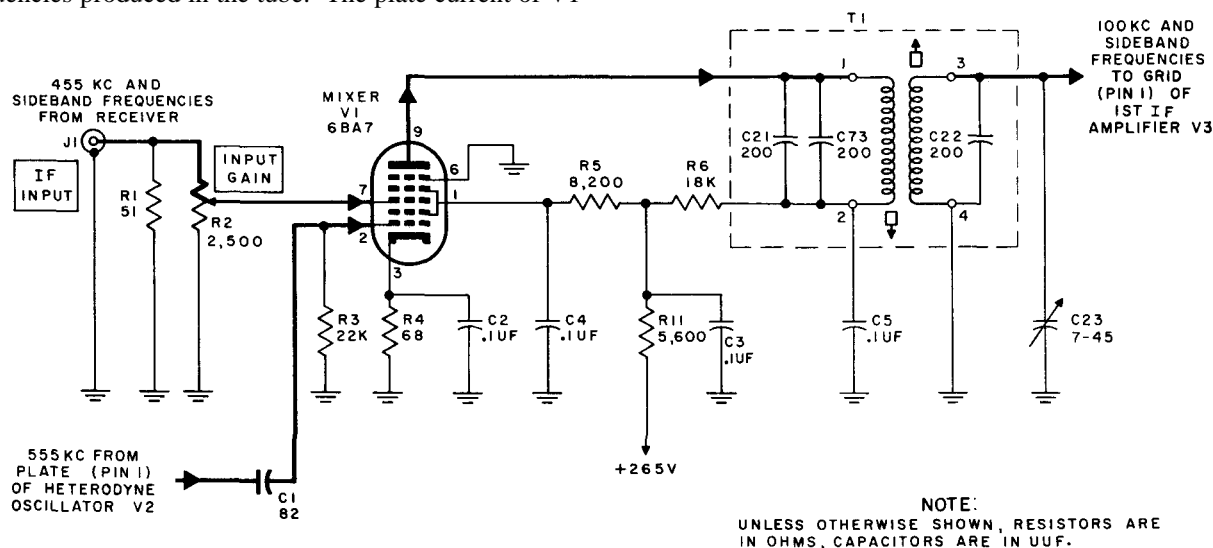
flows through the slug-tuned primary of if. transformer T1. This primary inductance, in parallel with tuning capacitors C21 and C73, provides a plate load resonant at 100 kc, when the slug core is correctly adjusted. The slug core of the transformer secondary provides a coupling adjustment. Fixed capacitor C22 and trimmer C23 resonate the transformer secondary.

d. The mixer develops cathode bias across R4, which is bypassed through C2. Resistors R2 and R3 return the grids to ground. The screen voltage is held at the required dc potential by dropping resistor R5, which is bypassed by C4. Plate voltage for V1 is applied through R6, which is bypassed by C5. The decoupling network formed by R11 and C3 effectively prevents any rf. at the plate and screen of V1 from reaching the converter high-voltage power supply.

## 10. Heterodyne Oscillator

(fig. 9)

a. Oscillator V2 uses a dual triode in a modified multivibrator circuit. The circuit is a two-stage capacity-resistance-coupled amplifier that feeds back on itself to sustain oscillation. A very small positive voltage, applied to the control grid (pin 2) of V2, is amplified, coupled through C19 and appears at the grid (pin 7) of V2. The signal is further amplified and feedback is achieved through C16 and C15 to the grid (pin 2) of V2. Such an



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Figure 8. Input and mixer stage, schematic diagram.

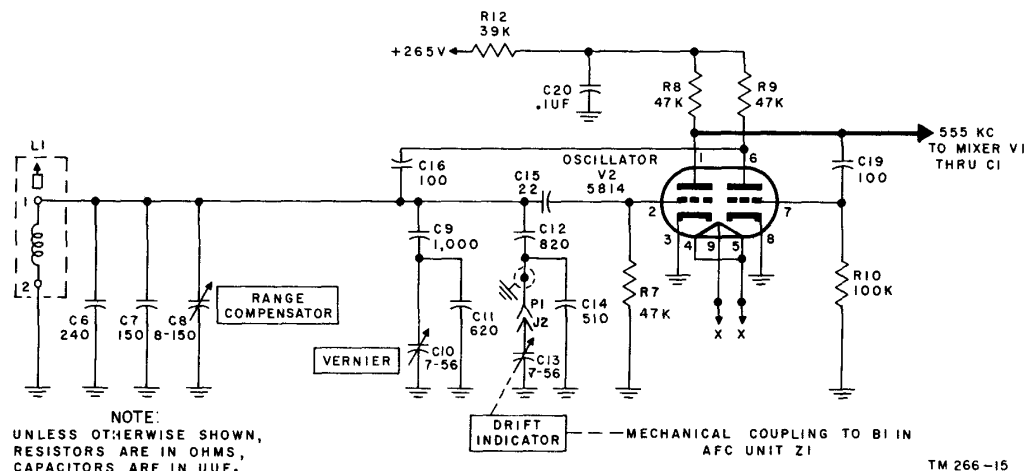


Figure 9. Heterodyne oscillator, schematic diagram.

arrangement oscillates because each triode section produces a phase shift of  $180^\circ$  which results in a feedback from one section to the other, with the necessary phase to sustain oscillation. The oscillator plates are loaded by R8 and R9 and are decoupled from the high-voltage power supply by R12 and C20.

b. The frequency determining elements of the oscillator are in the grid circuit (pin 2) of V2. These are L1 and C6 through C14. A variety of capacitors is used in the network to provide linearity with those attached to calibrated control knobs. Variable inductor L1 and the RANGE COMPENSATOR, C8, may be adjusted to provide for if. input frequencies, at J1, within the range of 450 to 510 kc (fig. 51). Mechanical drive to C10 is geared down from the VERNIER control knob on the converter front panel. A planetary (outer) disk around the knob indicates the relative position of the rotor plates of vernier capacitor C10 and an indicator line on this disk lines up opposite appropriate calibration markings on the front panel. Capacitor C10 offers an adjustment of  $\pm 2$  kc in the frequency of the heterodyne oscillator. The accuracy of the VERNIER calibration is maximized by the correct adjustment of C8 and L1 during the converter tuning procedure. Variable capacitor C13 is mechanically coupled to motor B1 (fig. 46). Capacitor C13 is controlled through the equipment afc circuit to hold the converter if. center frequency at exactly 100 kc despite frequency variations in the signal that is delivered to the converter from the receiver. Capacitor C13 is also mechanically coupled to the DRIFT INDICATOR control knob on the converter front panel. The pointer of this

knob moves across a calibrated scale to indicate the amount of frequency drift in the converter input. Capacitor C13 may also be manually adjusted by using the DRIFT INDICATOR control.

## 11. First If. Amplifier

(fig. 10)

a. The output of T1 is delivered to the control grid (pin 1) of first if. amplifier V3. Amplifier V3 is a sharp cutoff pentode, used in an amplifying circuit. The circuit amplifies the output of mixer V1 (fig. 8) and further attenuates unwanted frequencies that appear in the mixer output. The plate load of V3 consists of the tuned network formed by the primary of T2 and by capacitors C26 and C27. Resistor R15 slightly lowers the Q so that the circuit of V3 has broad-band amplification characteristics. The secondary winding of T2 is tuned by a variable slug and capacitors C28 and C29.

b. Tube V3 is decoupled from the high-voltage power supply by R16 and C25. Resistor R14, bypassed by C24 is the screen-dropping resistor. Cathode bias for the stage is developed across R13. Grid is returned to ground through the secondary of T1.

## 12. Converter Upper and Lower Sideband If. Amplifiers

(fig. 11)

a. Two identical stages, V4 in the converter upper sideband and V11 in the lower sideband, provide

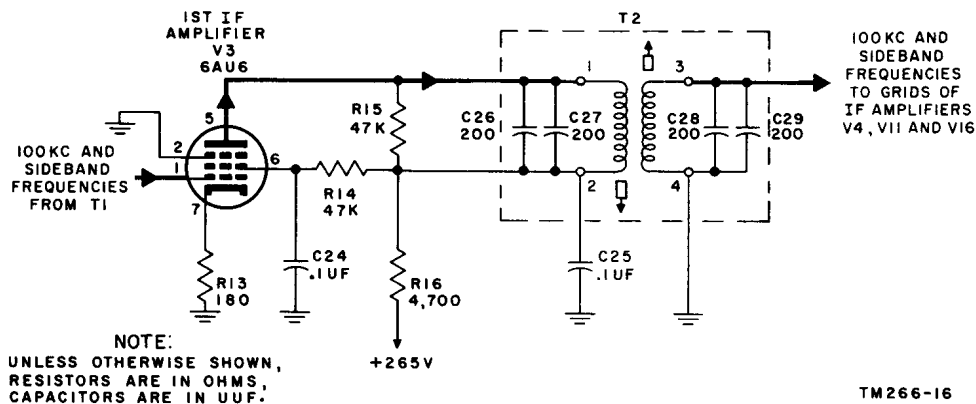


Figure 10. First if. amplifier, schematic diagram.

the necessary injection voltage for a satisfactory output voltage from sideband filters FL1 and FL3. The converter upper sideband will be discussed fully in this section; it differs from the lower sideband only in the frequencies involved. The if. output of T2 is coupled to the control grid (pin 1) of V4 through C30 and R17. The input signal is dropped across the L-pad, formed by resistors R17 and R18, which isolates the amplifier from the three other stages fed by T2. Tube V4 is a sharp cutoff pentode; the plate load is tuned by the network comprising the primary of T3, capacitor C34, and trimmer C33. Trimmer C33 is adjusted so that the network is peaked at 104 kc. The output curve of the transformer is flat across the upper sideband frequencies, with very little file attenuation to carrier and lower sideband frequencies. Resistor R21 lowers the Q in the tuned circuit, providing for wide-band amplification in V4.

b. The output from the secondary of T3 is delivered into resistive padding network R23, R25, R27, R26, R24, and R28. This network provides the correct input impedance to upper sideband filter FL1, and also isolates the filter to prevent detuning and other undesirable effects. Filter FL1 is a band-pass filter that allows the frequencies between 100.1 and 106 kc to pass freely, and attenuates sharply all other frequencies.

c. The output of FL1, which consists of the converter upper sideband frequencies, is delivered, through pad resistors R260 and R261, across impedance-matching resistors R29 and R30 to the untuned primary of T4. Proper impedance matching at input and output of each filter insures best band-pass characteristics. The secondary of T4, also untuned, has one side grounded, while the other side is connected to SB SELECT switch S1 (fig. 12).

d. Tube V4 develops cathode bias across R19. The screen of the amplifier is decoupled from the high-voltage power supply by network R20, C31, and C32. The plate dropping resistor for the stage is R22.

e. In the lower sideband, V11 and its associated components perform identical functions with those in the upper sideband, except that the frequencies selected by T6 and FL3 lie in the range of 94 to 99.9 kc. These frequencies are the converter lower sideband frequencies that correspond to the transmitted upper sideband frequencies. An additional capacitor, C62, is placed across the primary of the output transformer of V11. Capacitor C62 enables the transformer to be tuned to the lower frequencies that are desired as an input for FL3.

### 13. Channels A and B Sideband Amplifiers

(fig. 12)

a. The outputs of upper and lower sideband filters FL1 and FL3 are applied through T4, T7, and SB SELECT switch S1 to channels A and B sideband amplifiers V5A and V12A, respectively.

b. The intelligence delivered at the channels A and B outputs is selected by the position of SB SELECT switch S1. This switch has two positions, A-LSB, B-USB and LSB-B, USB-A. These markings refer to the sideband frequencies *as transmitted*, when the converter is used with Radio Receiver R-390/URR or any receiver with an equivalent system of input frequency conversion.

c. Because of the reversal of frequency relationships caused by the converter input signal heterodyning, S1 selects the converter *upper* side-



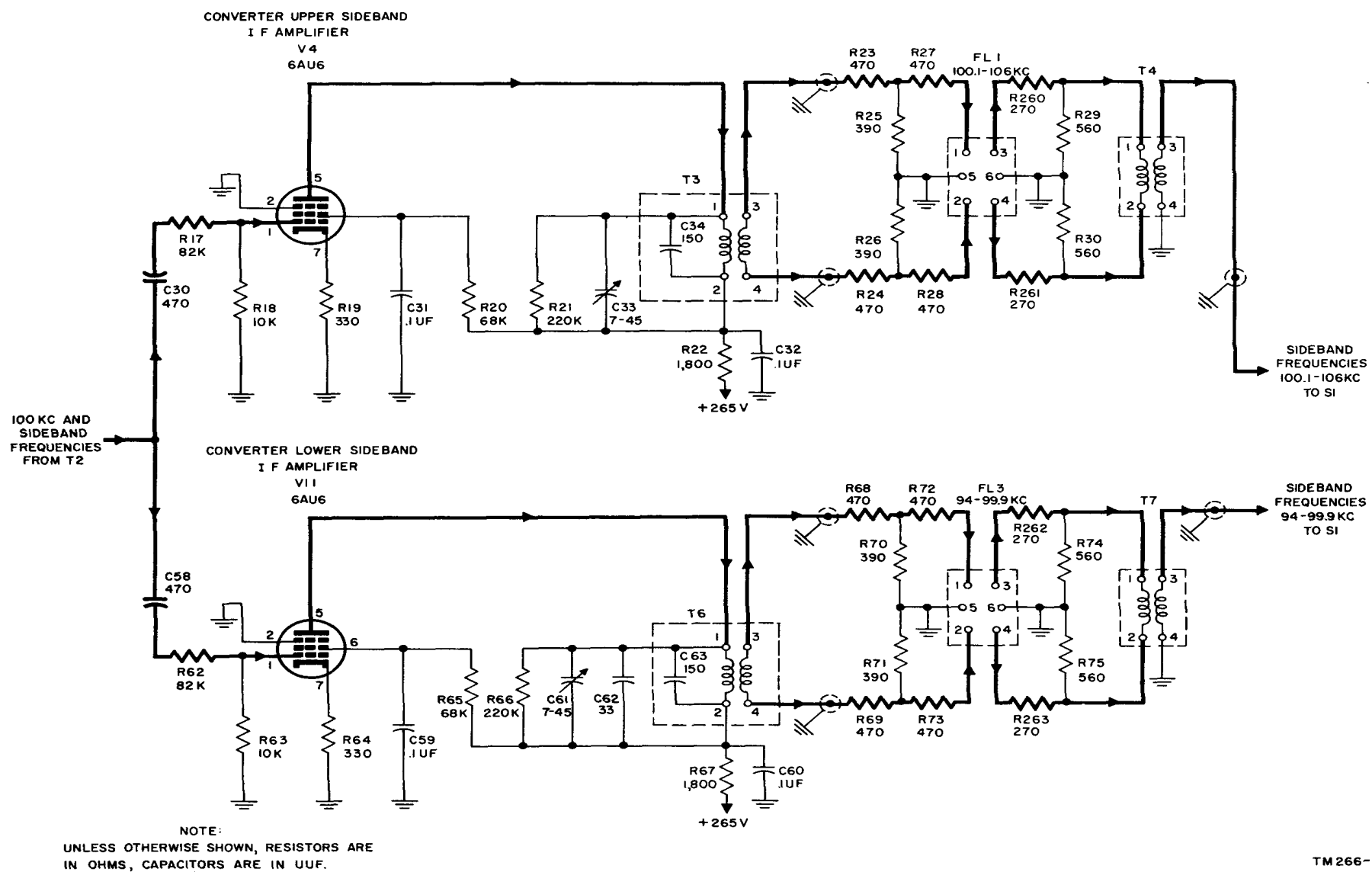
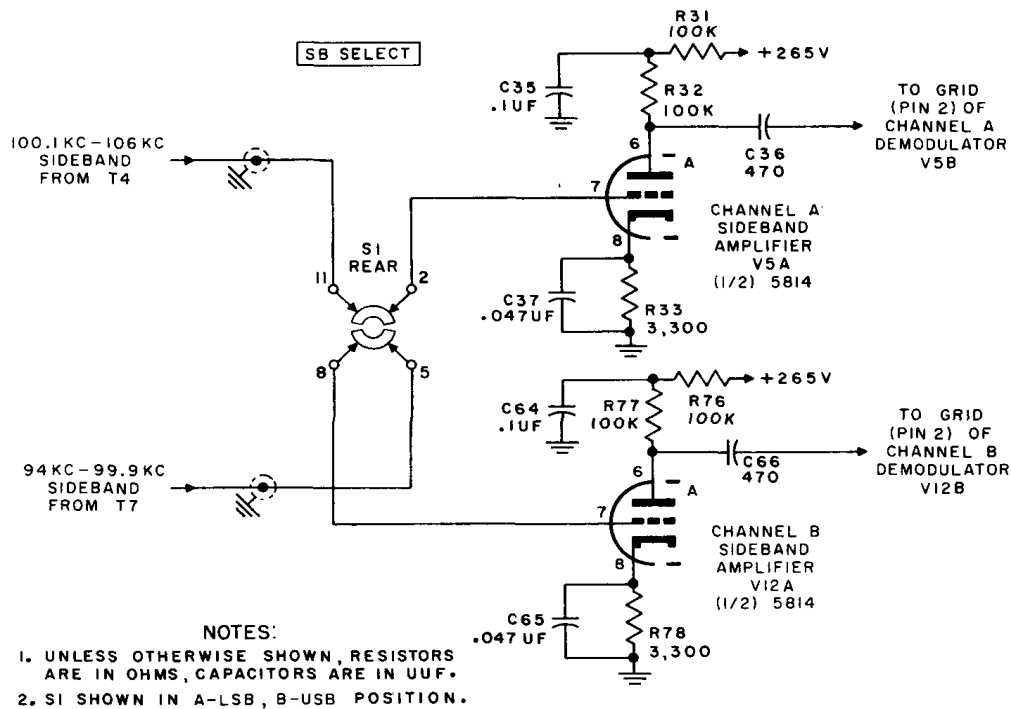


Figure 11. Sideband if. amplifiers and filters, schematic diagram.



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Figure 12. Channel and B sideband amplifiers, schematic diagram.

band frequencies to be delivered to channel A, and the converter *lower* sideband frequencies to be delivered to channel B in the A-LSB, B-USB position. In figure 12, switch S1 is shown in the A-LSB, B-USB position. The converter upper sideband frequencies are applied from T4 to contact 11 of S1, through the switch rotating element to contact 2, and to the control grid (pin 7) of channel A sideband amplifier V5A. Simultaneously, the output of T7, which consists of the converter lower sideband frequencies, is applied to contact 5 of S1, through another rotating element, to pin 8 of the switch, and to the control grid (pin 7) of channel B sideband amplifier V12A. When the switch is placed in the LSB-B, USB-A position, the elements are rotated so that the converter upper sideband frequencies are applied through contacts 11 and 8 to pin 7 of V12A. The lower sideband frequencies are applied through contacts 5 and 2 to pin 7 of V5A.

d. Sideband amplifiers V5A and V12A are Class A triode amplifiers, which amplify the sideband frequencies before they are applied to the demodulator stages. In channel A the output of V5A is applied across load resistor R32 and is coupled to the next stage through capacitor C36. The plate is decoupled from the high-voltage supply by R31 and C35. Cathode bias is developed across R33, which is bypassed by C37. The operation of channel B sideband amplifier V12A and its

associated components is the same as the operation of V5A.

## 14. Channels A and B Demodulators

(fig. 13)

a. In channel A, the demodulator stages consist of three triode sections, V5B, and the two halves of dual triode V6. There are two inputs to the demodulators. Sideband frequencies are coupled through C36 from V5A (fig. 12) and applied to the grid (pin 2) of V5B. A 100-kc carrier signal is applied to the grid (pin 7) of V6A. The 100-kc signal may be either the reconditioned carrier output of third carrier limiter V21 (fig. 17) or the output of the local carrier oscillator, V35 (fig. 20) depending on the position of CARRIER SELECT switch S6. A system of cathode mixing through a common cathode connection is used to combine the two input signals. The resultant frequencies are amplified in V6B. They are then applied to a filter where the unwanted frequencies are rejected, and only the difference (audio) frequencies are fed to the converter audio amplifying stages.

b. Actual mixing of the sideband and carrier frequencies takes place in R35, a cathode resistor common to V5B, V6A, and V6B. Tube V5B, driven by the application of sideband frequencies

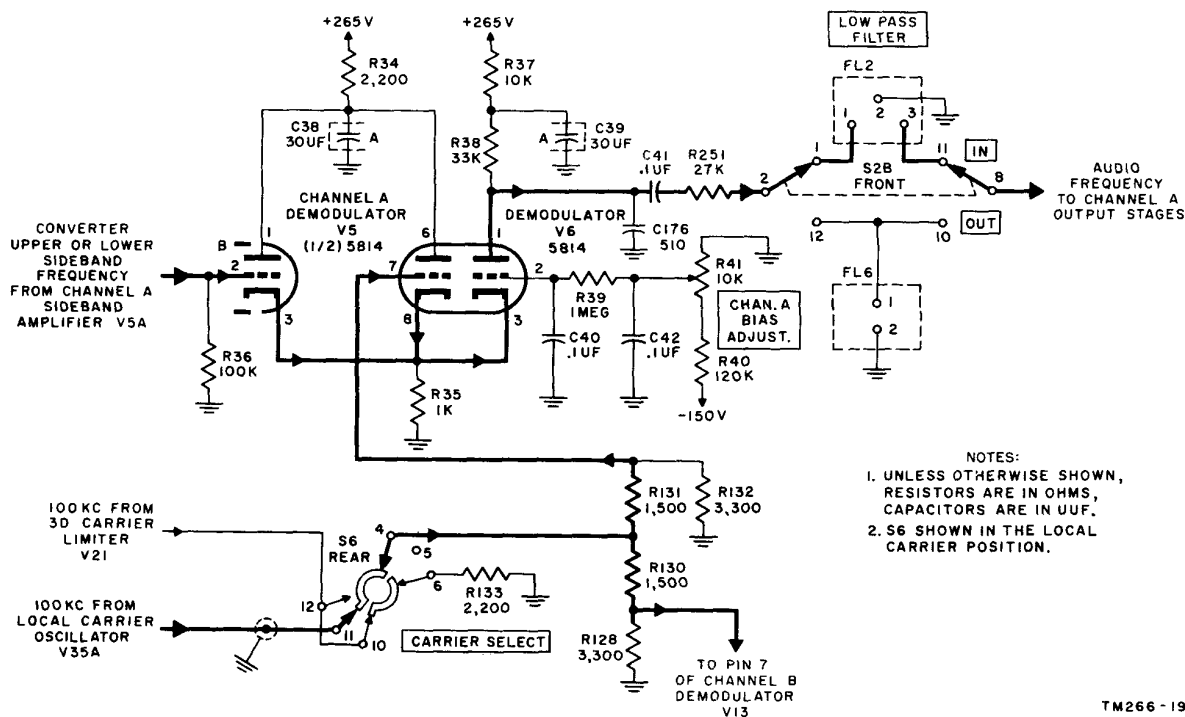


Figure 13. Channel A demodulators, schematic diagram.

at its grid, and V6A, driven by the application of 100 kc at its grid, function as cathode followers. Resistor R35 serves as a common load for both stages. Resistor V6B is a grounded grid amplifier, whose input voltages are developed across R35.

c. Resistor R36 is the grid return for V5B. Resistor R34 and C38A decouple V5B and V6A from the high-voltage power supply. The plate of V6B is decoupled by R37 and C39A. The grid of V6B is held at ground potential and decoupled from the stage adjustable bias source by the pi-network formed by C40, R39, and C42. The grid of V6B is connected to the negative bias supply through R40 and control R41, which is the CHAN. A BIAS ADJUST. The combination of resistors forms a variable vernier bias adjustment for V6B so that minimum distortion appears in the audio-frequency output of the amplifier.

d. The output signal of V6B, developed across R38, consists of the various products that are formed by mixing the converted carrier frequency with the sideband frequency on the cathodes of the demodulator strip. Rf components in the output of V6B are bypassed to ground by C176 while af components are coupled through C41 and R251 to the B wafer of LOW-PASS FILTER switch

S2. Switch S2 is a rotary switch (fig. 67) with two sections, A and B, which are ganged together. The bandwidth of the converter audio output signal is regulated through this switch, which selects one of two filters to be placed in the output circuit of V6B. The frequencies that are delivered from V6B contain many elements. Only one of these (the *difference* between the carrier frequency and the sideband frequency) is in the audio range. Therefore, filtering out the unwanted high-frequency components is easy. In the OUT position of S2, the output of V6B is connected through contacts 2 and 12 of S2B and is applied to the 100 kc series-resonant circuit contained in filter assembly FL6. In FL6, the converter if. Components of the signal as that may appear at contact 2 of S2B despite prior filtering are bypassed to ground, and only the desired audio frequencies pass on through contacts 10 and 8 of S2B to the audio amplifying stages of the converter.

e. With S2 in the IN position, the output of V6B is fed through contacts 2 and 1 of S2B to low-pass filter F12. This low-pass filter passes all frequencies up to 3.5 kc, and attenuates higher frequencies 55 db down from the levels of the audio

frequencies it passes. Thus, FL2, like FL6, rejects the high frequencies present in the output of V6B, and passes only the audio frequencies through contacts 11 and 8 of S2B to the channel A audio output stages.

f. Channel B demodulator stages are identical with those used in channel A, and the components perform the same functions.

g. The 100-kc signal that is necessary to demodulate the sideband frequencies is delivered to V6A from S6, the CARRIER SELECT switch on the front panel. Converted carrier frequencies are fed to this switch from two sources: local carrier oscillator V35A (fig. 20) and third carrier limiter V21 (fig. 17). By placing S6 in the LC position, the output of local carrier oscillator V35A is fed through contacts 11 and 4 of S6, which are applied across isolating and dropping resistors R131 and R132. In this position of S6, the *reconditioned carrier* output of the third limiter is grounded through R133. This simulates the loading of the demodulator circuits, and thus prevents the circuit of the third limiter from becoming unbalanced when its demodulator output is not being used.

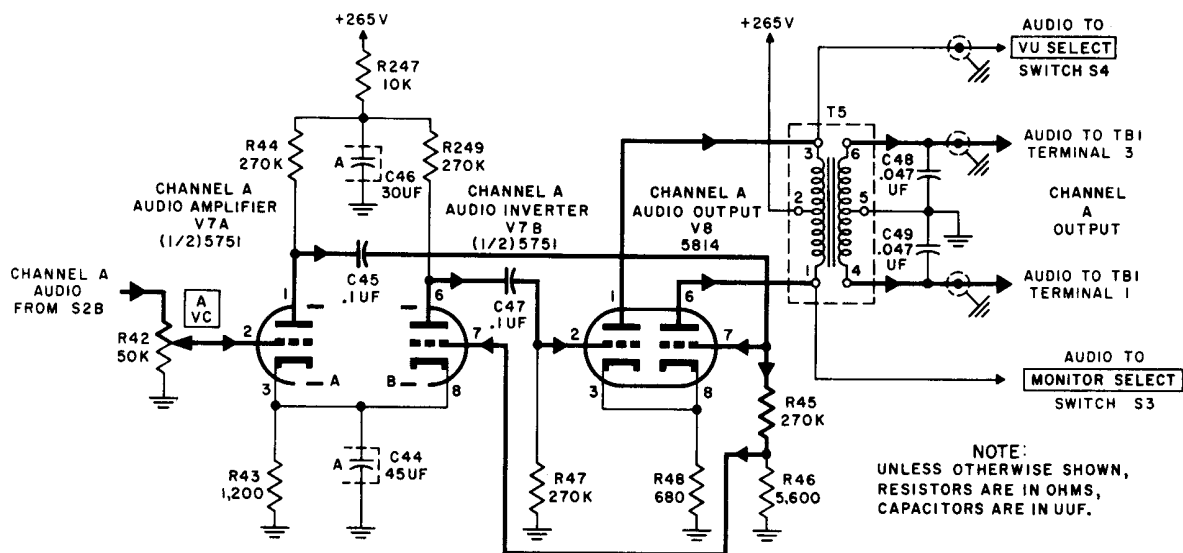
h. In the RC position of S6, the reconditioned carrier is fed through contacts 12 and 4 of S6 to the demodulators, and the output of the local carrier oscillator is grounded through R133. The equipment is normally operated with S6 in the LC position. Use of the locally generated carrier assures that intelligence will not be lost because of short term carrier fading or the introduction of noise to the demodulator circuit.

## 15. Channels A and B Audio Output Stages

a. The output of the channel A demodulator strip is fed to a push-pull output stage that consists of two dual triodes, V7 and V8 (fig. 14). In channel B, an identical output stage is used, consisting of dual triodes, V14 and V15 (fig. 67). Channel A output is delivered to terminals 1 and 3 of TB1. The output of channel B is fed to terminals 4 and 6 of the same terminal board. The output stages of channel A and B are identical, except for symbol numbers; therefore, only the channel A circuit will be explained in detail here.

b. The output of the demodulator filters is applied across control R42, which is the A-VC screwdriver adjustment on the equipment front panel. This control adjusts the input amplitude of the audio frequency that is fed to V7A to provide a proper converter output level to its associated terminal equipment.

c. From R42, the signal is fed to the grid (pin 2) of first audio amplifier V7A. Amplifier V7A is a triode amplifier which is operated Class A. The output is developed across plate load resistor R44. Part of the output of V7A is coupled through C45 to the grid (pin 7) of amplifier V8. Another part of the amplifier output is applied across R45 and R46. These values have been selected to provide the proper voltage for balanced push-pull operation of the output stages. The result is to provide an output from inverter V7B



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Figure 14. Channel A audio stages, schematic diagram.

that is developed across plate load resistor R249, which is 180° out of phase with the output of V7A. The output of V7B is coupled through C47 to the control grid (pin 2) of channel A output amplifier V8. The plates of V7 are decoupled from the high-voltage supply by R247 and C46A. Resistor R43, bypassed by C44A, serves as a cathode bias resistor common to both halves of V7.

*d.* The bias for the output amplifiers in V8 is developed across unbypassed common cathode resistor R48. The plate load for the two halves of V8 is provided by the primary winding of center tapped output transformer T5. Transformer terminal 1 is connected to the plate (pin 6) of V8, and transformer terminal 3 is connected to the plate (pin 1) of V8. Terminal 2 of the transformer is the primary center tap, which is connected to the high-voltage power supply, providing plate voltage for the two output triodes. Because the two input signals to V8 are delivered 180° out of phase, the outputs of the two amplifiers appear across the primary of T5, 180° out of phase. This causes the high output level that is characteristic of a push-pull amplifying stage.

*e.* The output of T5 is balanced to ground by connection of the secondary center tap to ground (transformer terminal 5). Terminals 4 and 6 of the secondary are connected to TB1 terminals 1 and 3, respectively. Capacitors C48 and C49 are connected across each half of the center-tapped secondary to bypass any rf (100 kc).

## 16. Carrier If. Amplifier and Filter

(fig. 15)

*a.* The output of if. transformer T2 is delivered to carrier if. amplifier V16 and is fed to the sideband amplifying and separating strips. The converter if. signal contains sideband frequencies, as well as the converted carrier frequency. Therefore, the output of V16 is fed to a very sharply tuned filter, FL5, where the carrier component (present in the if. signal) is separated from the sideband frequencies; then the component may be further reconditioned for use in the afc circuit and the demodulators.

*b.* The output of T2 is coupled through C77 to the grid of V16, across the dividing and isolating pad comprising R100, R101, R102, and R103. This pad lowers the signal level which is applied to V16 to an appropriate value and, at the same time, enables a portion of the if. signal to be tapped off at the junction of R101 and R103. This signal is used in the converter agc circuit (figs. 26 and 27).

*c.* Amplifier V16 uses a sharp cutoff pentode. Cathode bias for the amplifier is developed across R104, which is bypassed by C78. The suppressor of V16 is grounded and screen voltage is applied through screen grid dropping resistor R105 which is bypassed by C79. Capacitor C80 and resistor R107 decouple the stage from the high-voltage power supply.

*d.* The output signal of V16 is developed across plate load resistor R106, and coupled through C81 to voltage divider R108 and R109. Carrier filter FL5 receives its input from the junction of these two resistors. The filter is very sharply peaked at 100 kc and has a pass band of approximately 20 cycles per second (cps). The values of C82 and C83, in addition to R110 in series with R111, have been chosen by the manufacturer to terminate the secondary of the filter and should not, under any circumstances, be changed.

*e.* The 100-kc output of FL5 is applied across the resistive pad formed by series-connected resistors R110 and R111. The signal developed at the junction of these two resistors is delivered through R112 to first carrier amplifier V17 (fig. 16).

## 17. Carrier Amplifying Stages

(fig. 16)

*a.* Two tuned amplifiers are used to amplify the 100-kc output of FL5 before the signal is delivered to a three-stage limiting strip. The amplifier circuits are very similar in form; the two stages use sharp cutoff pentodes operated Class A.

*b.* The output of FL5 is applied across the variable attenuator formed by resistor R113 and CARRIER COMPENSATOR control R112. This control is adjusted for an ideal output level from the carrier amplifying stages. The level is fed to the carrier limiter strip and, at the same time, regulates the voltage applied in the CAR position of the AGC SELECT switch to a reference level (par. 30). Proper adjustment of R112 is indicated by a midscale reading on the (CARRIER LEVEL meter, which is fed by the output of the second carrier amplifier. The output of V17 is delivered to the primary of T9 which is slug-tuned and paralleled by capacitors C87 and C88 to form a resonant circuit. The secondary of T9 is slug-tuned and paralleled by C89 and C90 to form a resonant circuit. One side

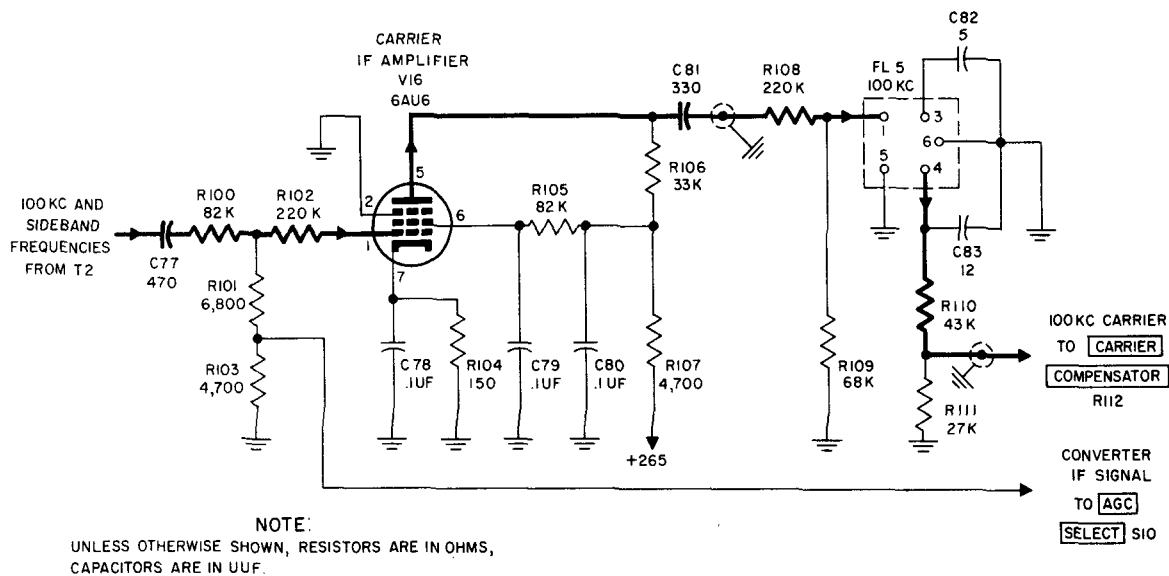


Figure 15. Carrier if. amplifier, schematic diagram.

of the transformer secondary is grounded, while the other side is connected directly to the control grid (pin 1) of amplifier V18.

d. The plate circuit of V18, like V17, is loaded by the net work that is formed by the primary of a tuned transformer. Variable transformer T110 is slug-tuned and paralleled by C96 and C97 to form a resonant circuit. Capacitors C98 and C99 perform the same function across the secondary winding. Variable capacitors C94 and C95 form an adjustable voltage divider. This divider enables a standard voltage output to be delivered from the carrier section to the converter age section for developing age voltage. This voltage controls the receiver that is used with the converter (fig. 26 and 27).

e. Amplifier V17 develops cathode bias across R114, which is bypassed by C84. Resistor R117 and C91 perform a similar function for V18. The screen of V17 is dropped to an appropriate dc value by R115 which is bypassed by C85, while R118 and C92 performs the same function for V18. The plate and screen of V17 are decoupled from the power supply by network, R116 and C86, while R119 and C93 form the decoupling network for V18.

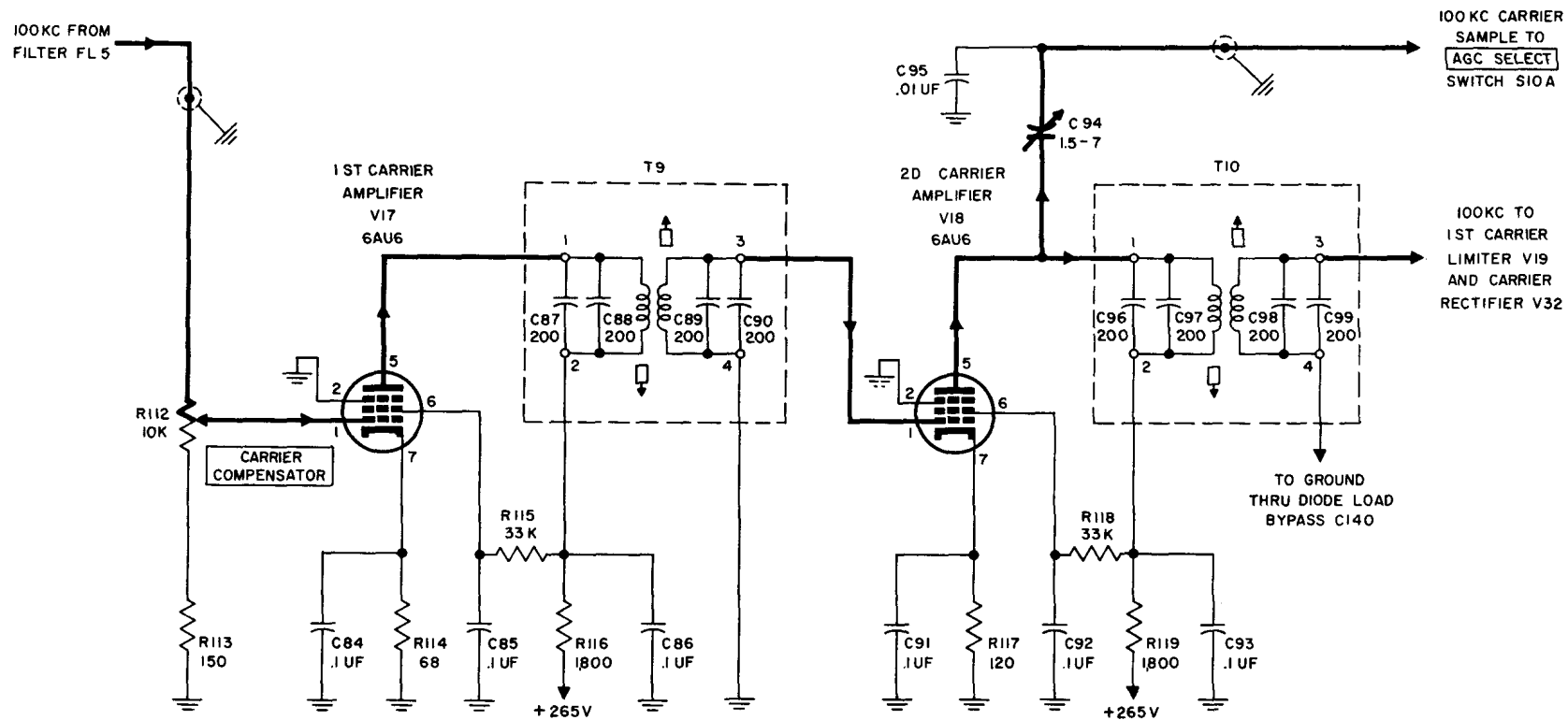
f. Part of the output of the carrier amplifying stages is fed to the limiter strip (fig. 17). However, part of the output is also delivered from the secondary of T10 to (pin 7) of squelch voltage rectifier V32 (fig. 18), and a portion directly from the plate of V18, through a voltage divider,

to the converter age circuit (fig. 26). Terminal 4 of T10 is held at effective alternating-current (ac) ground potential through diode load bypass capacitor C140, for squelch voltage rectifier V32 (fig. 18).

## 18. Carrier Limiting Stages (fig. 17)

a. The 100-kc output of T10 is delivered to the carrier limiting stages which use dual triodes V19, V20, and V21. The circuits of these three stages are almost identical. The limiting strip performs two distinct functions. The limiters assure application of a noise-free reconditioned carrier of unvarying amplitude to the afc and demodulating circuits. Any noise present in the output of T10 is detected at the second limiter and delivered to the converter squelch circuit (fig. 18) where the noise voltage, if excessive, disables the converter afc circuit.

b. The output of T10 is coupled through C100 and applied across R120 to the control grid (pin 2) of first carrier limiter V19. Limiter V19 is a twin triode cathode-coupled amplifier. It achieves symmetrical limiting because the first section is cut off on negative peaks of input and the second section is cut off on positive peaks of input applied at the grid (pin 2) of V19. The first section of V19 functions as a cathode follower; its plate is placed at ac ground potential through C101. The triode is biased just above cutoff by R121. The first section will pass all signals delivered to



NOTE:  
UNLESS OTHERWISE SHOWN,  
RESISTORS ARE IN OHMS,  
CAPACITORS ARE IN UUF.

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Figure 16. Carrier amplifying stages, schematic diagram.

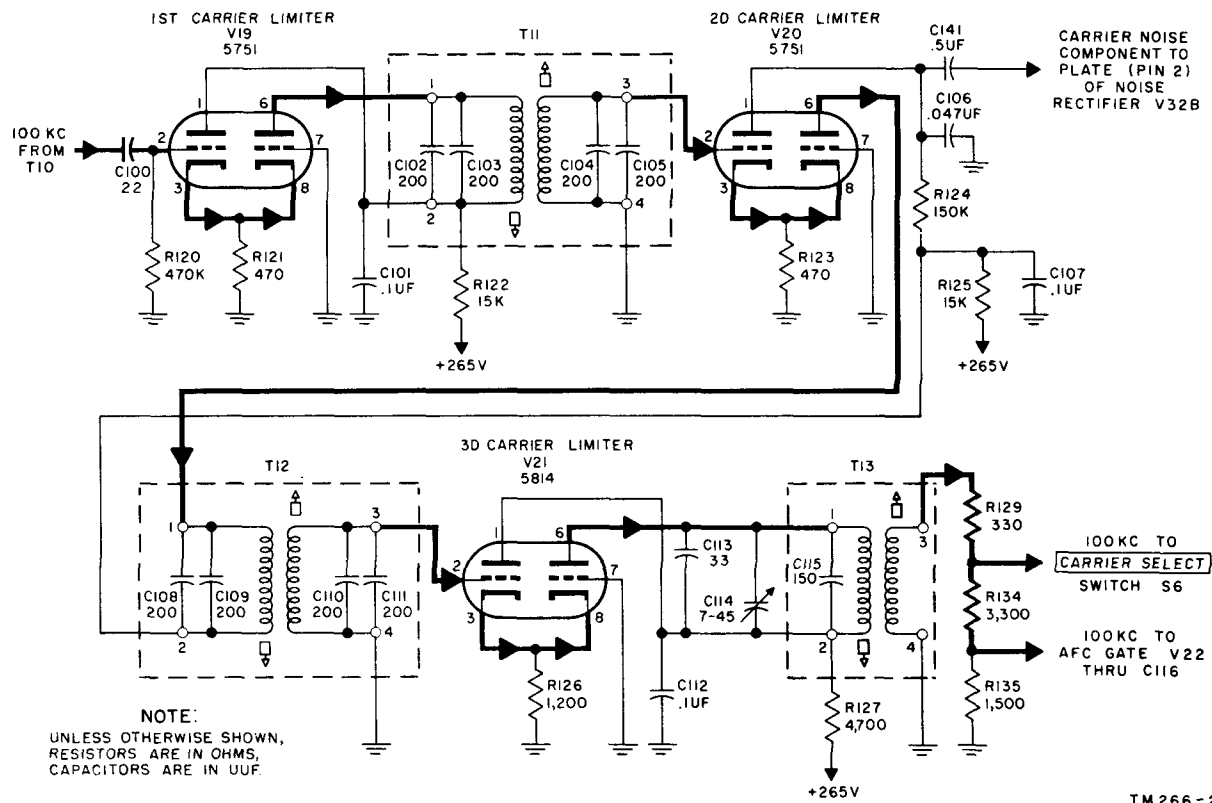


Figure 17. Carrier limiter section, schematic diagram.

it from T10, except the negative peaks of its input signal that drive the section below cutoff. The second section of V19 operates as a grounded grid amplifier, the input signal of which is developed across R121. Because of the nature of the bias applied to this second section, the tube will cut off on the positive peaks of its input (the first section passes the positive peaks of its input), thus effecting the limiting action. The output of the stage is delivered from (pin 6) of V19 to transformer T11. The primary of T11 is tuned by fixed capacitors C102 and C103 and a variable slug; the secondary by fixed capacitors C104 and C105 and a variable slug. Resistor R122 is the plate dropping resistor for V19.

c. Second carrier limiter V20 operates the same as V19. However, noise components are detected and filtered off in this stage for delivery to the converter squelch circuit. The value of C106, in the plate circuit (pin 1) of V20, has been selected to bypass only the 100 kc component to ground. Because of the nonlinear characteristic of the stage, noise elements modulating the carrier frequency are detected in V20, and coupled through C141 to noise squelch rectifier V32 B (C, fig. 16).

d. Otherwise V20 is identical with the stage preceding it. Input signal voltage to the grounded-grid amplifying section is developed across R123. The output (pin 6) of V20 is fed to the primary of T12 which is tuned by fixed capacitors C110 and C111 and a variable slug. The secondary of the transformer is tuned by fixed capacitors C110 and C111 and a variable slug.

e. The output of T12 is fed directly to the control grid (pin 2) of the third limiter V21. Limiter V21 operates like the two preceding limiter stages. The plate of the cathode follower (pin 1) of the third carrier limiter is placed at ac ground potential through C112. Input signal voltage to the grounded-grid amplifying section is developed across R126. The output of V21 is fed to T13, which has its primary peaked at 100 kc by fixed capacitors C113 and C115, trimmer C114 and a variable slug. Resistor R127 is the plate dropping resistor for the stage.

f. One side of the secondary of T13 is grounded. The other side applies the output of the limiter strip across resistive voltage dividing network R129, R134, and R135. The limiter output to the demodulator section (fig. 13) is tapped off at the



junction of R129 and R134, and is delivered to CARRIER SELECT switch S6. The output to the afc circuit is tapped off at the junction of R134 and R135, and is fed to the control grid of afc gate V22.

## 19. Squelch Circuit

(A, fig. 18)

a. The converter has a squelch circuit that disables the afc circuit when the signal-to-noise ratio in the carrier amplifying strip drops too low in value to exercise proper control.

b. The circuit uses a dual diode, V32, and two dual triodes, V33 and V34. Part of the output of the carrier amplifying section (par. 17) is delivered to (pin 7) of V32, which rectifies this output and applies a dc bias voltage to the grid (pin 2) of V33. When the signal strength applied to (pin 7) of V32 (the signal delivered to the carrier limiting strip) falls below a suitable level, V32 triggers V33. Tube V33, in conducting, acts through amplifier V34 to cut off afc gate V22 (fig. 19), and disables the afc circuit. Tube V33, in conducting, acts through amplifier V34 to cut off afc gate V22 (fig. 19), and disables the afc circuit. The noise delivered from the first to the second limiter (fig. 15) is rectified in V32. This diode is connected to the grid (pin 7) of V33 and keeps the triode section normally cut off. If the amount of noise delivered to the second limiter rises above a minimum level, tube V32 conducts and triggers V33. Tube V33 conducts through the plate (pin. 6) and causes amplifier V34 to cut off afc gate V22, which disables the afc circuit.

c. Two rectifiers are used to measure signal-to-noise ratio in the circuit. When the signal fades, the output of the carrier amplifying section is inadequate for the limiter strip to build up the signal amplitude that is necessary for proper operation of the afc circuit. In this case, V32 applies squelch. However, *any* output of the carrier amplifying section will cause V32 to conduct, whether that output be converted carrier or noise. The noise frequencies are separated at the second carrier limiter and applied to (pin 7) of V32, which starts the squelch operation. When the carrier is too low (in amplitude) to be built up to sufficient strength in the limiter strip, squelch is applied. When the noise level is too high to be clipped by the first limiter strip, squelch also is applied. The squelch circuit measures the quality of the signal fed to the limiter strip, and closes the afc gate when the signal is unsuitable for afc circuit operation.

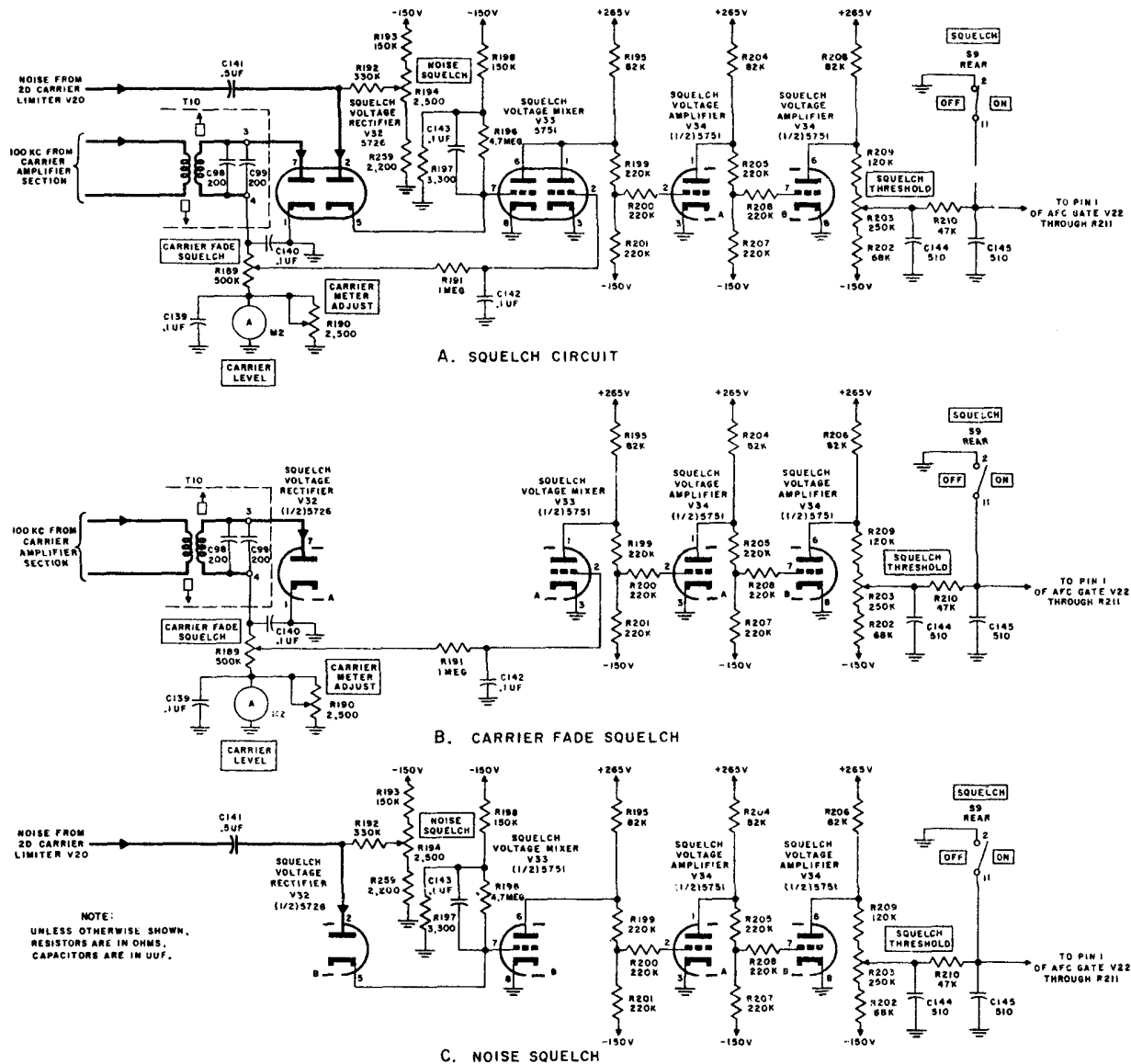
## 20. Carrier Fade Squelch Circuit

(B, fig. 18)

a. Section B of figure 18 shows the circuit used in the application of squelch voltage when pronounced fading on the part of the carrier signal is delivered from the carrier amplifying section. When the carrier fades, the signal-to-noise ratio decreases, and undesirable noise would appear in the output unless the carrier fade squelch circuit is in operation. This output, consisting of a 100-kc signal and any noise that may be present, is delivered from the secondary of T10 to two points; first carrier limiter V19 (fig. 17) and the plate of carrier rectifier V32A. This diode performs two functions, it rectifies the voltage fed to CARRIER LEVEL meter M2, and it provides a means for measuring the output level of T10 to operate the squelch circuit.

b. Operation of the carrier fade squelch circuit is as follows:

- (1) When the carrier fades (falls below a usable level), V32A will conduct less than with a strong carrier signal.
- (2) The negative voltage across CARRIER FADE SQUELCH control R189 will decrease (become less negative).
- (3) This change is applied to the grid of V33A through R191, causing it to become less negative until V33A begins to conduct.
- (4) The output signal level of T10, which causes V32A to maintain V33A in the cutoff condition, is determined by the setting of R189.
- (5) When V33 begins to conduct, the positive voltage at the junction of R199, R200, and R201 decreases to a value that will cause V34A to cutoff.
- (6) When V34A cuts off, the voltage at the junction of R205, R207, and R208 increases causing V34B to conduct.
- (7) When V34B conducts, the voltage across R203 (SQUELCH THRESHOLD) decreases, making the voltage at the arm of R203 more negative with respect to ground.
- (8) This negative voltage is applied to the grid (pin 1) of afc gate tube V22, causing it to cut off, and squelch is applied when the carrier fades.



**Figure 18. Squelch circuit, schematic diagram.**

## 21. Noise Squelch Circuit

(C, fig. 18)

a. Rectifier V32B operates the noise actuated portion of the converter squelch circuit. Noise frequencies from second carrier limiter V20 are coupled through dc blocking capacitor C141 and applied to the plate (pin 2) of V32B. The amplitude of this signal varies directly with the amount of noise, which is inversely *proportional to* the amount of signal, fed to the limiter strip. A certain fixed negative voltage is applied from the -150-volt dc supply through NOISE SQUELCH control R194, in series

with R193, and is placed on the plate of V32B. Resistor R192 connects the plate of V32B to the series-dropping network, at the same time isolating the high-impedance noise circuit from the low-impedance B supply. The setting of R194 determines the amplitude of the noise peaks necessary to overcome the negative voltage applied to V32B.

*b.* When the noise, peaks delivered to V32B are sufficient in amplitude to overcome the fixed negative volt-*age* applied to the plate, the diode begins to conduct. The cathode of V32B is connected directly to the grid of V33B. In the absence of

excessive noise, this circuit is held at a negative potential because the junction of the voltage divider, formed by R197 and R198 is connected to diode load resistor R196.

c. The operation of the balance of the noise squelch circuit is the same as that of the carrier fade squelch circuit (par. 20).

## 22. Afc Gate

(fig 19)

a. The output of the carrier limiter strip is fed to afc gate V22. Bias on the control grid (pin 1) of this sharp cutoff pentode is controlled by the squelch circuit. When the output of V21 is suitable for operation of the converter automatic frequency control circuit, V22 functions as an ordinary frequency triples, delivering 300 kc to the afc circuit. When the signal-to-noise ratio in the limiting trip is unsuitable for operation of the afc circuit, the control grid of the gate tube is automatically biased beyond the cutoff point through the operation of the squelch circuit. This prevents the unsuitable signal from entering the afc circuit and detuning the converter.

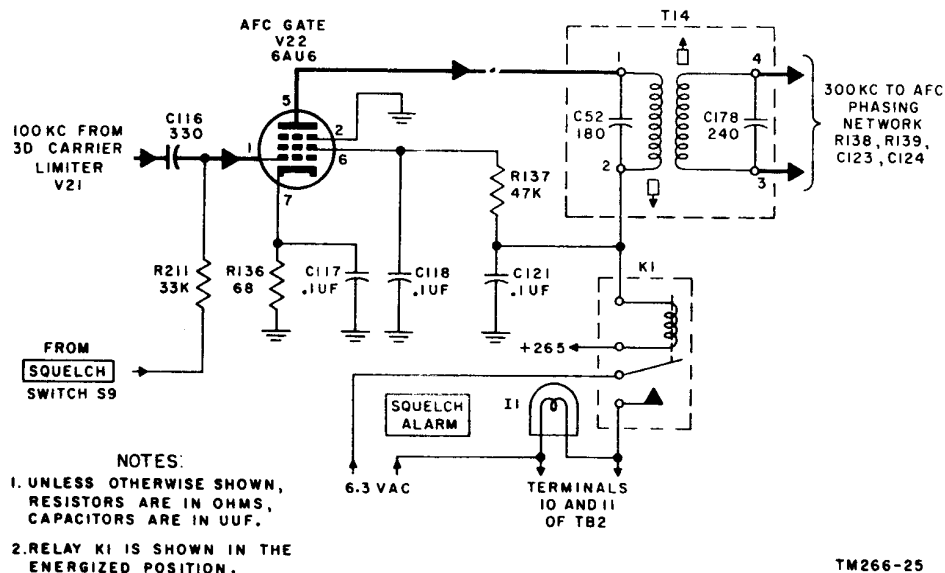
b. The output of the limiting strip is a 100-kc signal. The input to V22 is the originally transmitted carrier signal converted to a frequency of 100 kc; therefore any drift of the original signal will be reflected at the control grid of V22.

c. The cathode of V22 is biased by R136, which is bypassed by C117, in such a way as to slightly distort the

tube's output. This produces a signal that is rich in harmonics. The tube operates into a tuned plate load that is formed by the variable primary of T14. Both the primary and secondary of T14 are tuned. Transformer T14 provides the inductance (l) and the capacitors C52 and C178 provide the capacitance (c) for the tuned in inductance-capacitance (LC) circuit. The primary and secondary of T14 are adjusted to 300 kc by the two variable slugs. This 300 kc is triple the input frequency of V22. This tripling of the input frequency delivered from V22 to the afc circuit means that any error frequency present in the input of the gate tube will also be tripled, enabling a faster correcting action to take place in the afc circuit.

d. SQUELCH ALARM lamp I 1 on the equipment front panel lights when V22 is cut off; therefore, the operator is warned when the afc circuit has been inactivated by the squelch circuit. A pair of wires, in parallel with those of I 1, is connected to terminals 10 and 11 of TB2. This provides a remote squelch alarm indicator. The lamp circuit is 6.3 volts ac and operates from the equipment filament supply.

e. The switch for the squelch alarm circuit is located in relay K1. The winding for this current actuated relay is connected between the plate of V22 and the high-voltage power supply. When V22 conducts (and plate current flows) the relay pulls in, opening the switch connected to I1. If the afc gate is cut off by the squelch circuit, however, V22 ceases to draw plate current through the



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Figure 19. Afc gate V22, schematic diagram.

relay winding, and it releases. The contacts of the relay switch close, and allow I1 (and any external alarm indicator) to be lighted. The screen and plate decoupling network for V22 is formed by C121, C118, and R137.

### 23. Local Carrier Oscillator

(fig. 20)

a. A highly accurate, temperature-controlled crystal oscillator is used in the converter for generating a 100-kc *substitute carrier*. This 100-kc signal serves two functions in the converter: It provides an interference-free and nonfading substitute for the reconditioned carrier in the demodulator Circuits (par. 14). It is also used as a standard against which the reconditioned carrier is compared for operating the equipment afc circuit.

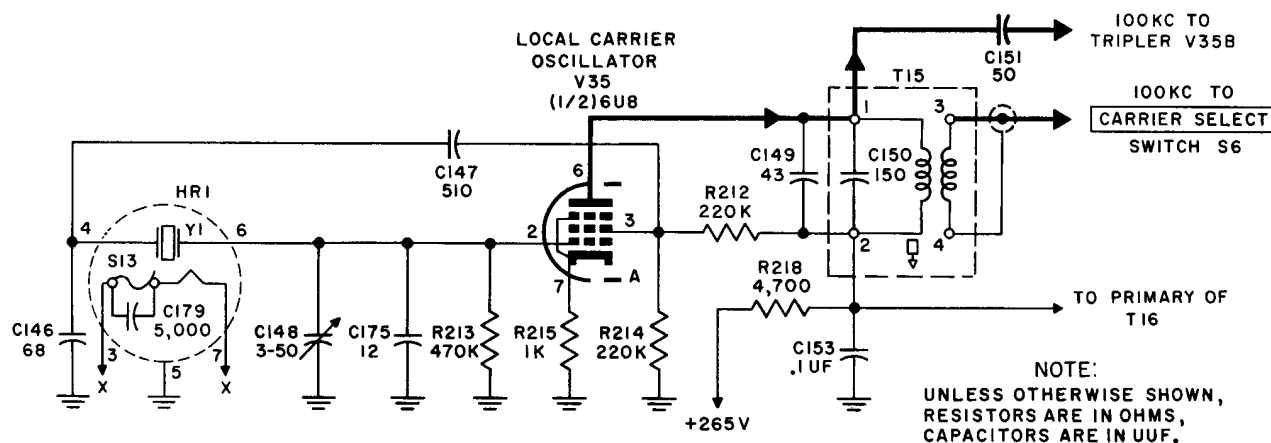
b. The oscillator uses V35A, the pentode section of triode-pentode V35, in an electron-coupled modified Pierce circuit. The frequency determining components for the oscillator are in the circuit of the first control grid (pin 2) of V35A. Quartz crystal Y1, operated at its fundamental frequency, takes the place of the LC tank in the circuit. Two capacitors, C175 and C148, are connected in parallel with Y1. These capacitors have a small effect in determining the frequency of the oscillator, and have been introduced in the circuit because of manufacturing considerations in the production of crystals. Trimmer C148 is principally used to adjust the local oscillator frequency to the exact center frequency of the carrier filter pass band. This trimmer may also be adjusted to compensate for changes in the overall

capacitance of the grid circuit, particularly those changes caused by the replacement of V35. Resistor R213 establishes the bias on the grid (pin 2) of V35A.

c. In an electron-coupled oscillator, the coupling that is necessary to sustain oscillation is achieved between the elements of the electron tube. The signal is coupled back to the control grid of the oscillator across the capacitive divider, formed by C146 and C147. Resistor R212 is the screen dropping resistor for the stage. Screen voltage is tapped off between R212 and R214, which, with R218 form a voltage divider network from B+ to ground.

d. The plate load of V35A is the primary winding of T15, which is tuned by fixed capacitors C149 and C150 and a variable slug. The 100-kc output of the oscillator is coupled through the transformer to CARRIER SELECT switch S6 on the front panel. The oscillator output is introduced to the demodulator circuits through this switch. A small part of the oscillator output is also delivered to the grid of tripler V35B (fig. 21).

e. Thermostat S13 (fig. 20) provides a means of controlling the temperature of the crystal (Y1). When the temperature surrounding S13 exceeds a predetermined level, S13 opens to prevent the filaments from heating the crystal. Once the temperature falls below the predetermined level, S13 closes to make contact and allow the filaments to heat. Capacitor C179, connected parallel to S13, prevents modulation from occurring in the oscillator caused by the *chattering* of the contacts during the making or breaking of contact.



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Figure 20. Local carrier oscillator, schematic diagram.

## 24. Tripler

(fig. 21)

a. Part of the output of local carrier oscillator V35A is coupled through C151 to the grid of triode amplifier V35B. This amplifier, operated Class B, is used to frequency-multiply the output of V35A for use in the afc circuit of the converter. Resistors R216 and R217 are used respectively to overbias the grid and cathode of the tube to produce an output from the amplifier that is rich in harmonics. This output is delivered to the plate of the amplifier load that is the tuned primary of T16.

b. The primary of T16 is tuned by fixed capacitor C71 and a variable slug; the secondary by fixed capacitors C180 and C181 and a variable slug. The transformer is peaked, by means of its variable core, to a frequency of 300 kc, which is triple the frequency of the local carrier oscillator (par. 23). The 300-kc of T16 is the tuned secondary to the input circuits of phase rectifiers V23 and V24, which form the beginning of the afc circuit of the converter.

c. Resistor R218 and C153 form a decoupling network common to the plate circuits of both V35A and V35B.

## 25. Afc Circuit

a. The function of the afc circuit is to assure that accurate audio frequencies are delivered from the converter to its associated carrier terminal equipment. This correct audio output is necessary if carrier terminal equipment is to function properly. The afc circuit is operated by the converted carrier frequency. A comparison circuit is used to detect any frequency difference between the output of the 100-kc standard (local carrier oscillator V35A) and the output of the third carrier limiter V21.

When operating at the end of the receiving system, the afc circuit corrects any drift in the transmitter or receiver output frequency, as well as any frequency changes arising in the converter. The circuit corrects by translating a frequency difference into the voltage pulses necessary to operate a motor. The motor drives a variable capacitor in the tank circuit of heterodyne oscillator, and corrects the oscillator frequency to maintain a converted carrier frequency of 100 kc.

b. The afc circuit terminates in motor B1 (fig. 11). This type of motor is an ac follow up device operating on the same principle as an induction disk watt-hour meter. The motor is commonly called a *drag cup* type because its rotor consists of an extremely light metallic cup on a shaft. The cup rotates between a distributed pole, two-phase stator and a fixed lamination stacks which is used to complete the magnetic circuit. The field windings set up eddy currents in the drag cup which react with the air gap flux to produce motor torque in this type of motor is proportional to the frequency of expansion decay of the field. In the afc circuit used in this converter, the outputs of two-phase rectifiers are used to excite the windings of the motor. The output frequency of the rectifiers is a function of the difference between the frequencies fed to them. The motor operates only when a phase difference of 90° exists between the signals applied across its windings; therefore, two motor drive strips are incorporated, the signal in one strip being 90° out of phase with that at any comparable point in the other strip. Wherever a difference frequency exists between the converted carrier frequency and the output of local oscillator V35A, an error signal is generated in each of the two-phase rectifiers. Because of the 90° phase

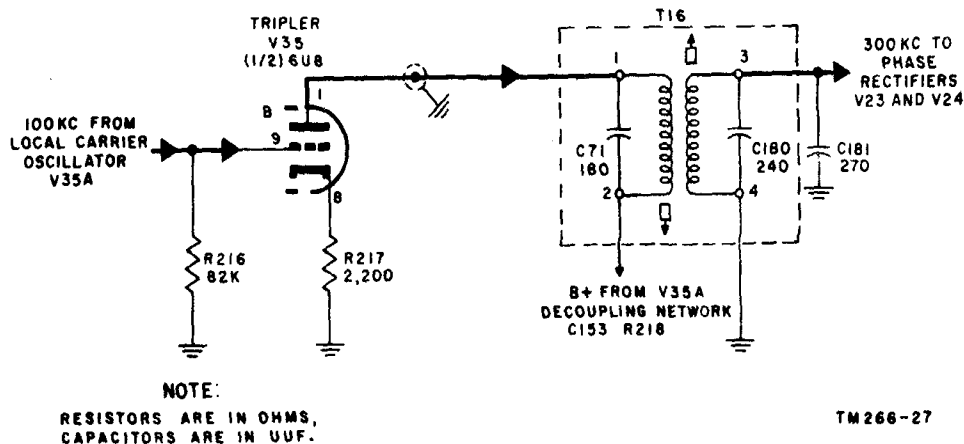


Figure 21. Frequency tripler V35B, schematic diagram.

shift introduced in the phase-shifting network, the error signal output of one rectifier is  $90^\circ$  out of phase with the error signal output of the other rectifier and thus provides the signal necessary to operate the motor whenever an error is present in the converted carrier if. The motor is mechanically coupled to capacitor C13, in the grid circuit of oscillator V2, through a reduction gear train of approximately 600 to 1 ratio.

## 26. Phase-shifting Network and Phase Rectifiers

(fig. 22)

a. The output of tripler V35B is coupled through C120 and C122 to be applied in series, effectively, with each end of the secondary of T14. Also appearing across this tuned circuit is the third harmonic output of afc gate V22. The energy at the secondary terminals is applied directly, through coupling capacitors C125 and C128, to the plates of the dual diode phase rectifier V24, and indirectly, through a phase shifting network, to the plates of phase rectifier V23. Because of the phase-shift effected in this network the output of V23 is  $90^\circ$  out of phase relative to that of V24. Little difference in *peak output* level exists between V23 and V24; however, instantaneously, the level out of one will be passing through maximum while the level out of the other is passing through zero. When the converted carrier frequency, is higher than the crystal oscillator frequency the output of one of the phase rectifiers will lead that of the other; while, conversely, when the converted carrier frequency is lower than the crystal oscillator, the lead-lag relationship of the rectifier outputs will reverse. This action in turn effects the reversal of direction of motor torque and the appropriate adjustment of C13 for correction of the mixing oscillator frequency.

b. The phase-shifting action may be demonstrated in the diagrams of figure 22B. Illustrated as a bridge network, the components R138, C123 C124, and R139 have been selected to present virtually equal reactances to the 300-kc energy appearing at the terminals of the secondary of T14. Current through leg b-a-e produces a voltage drop across R138, which leads the voltage across C123 as shown in the vectorial graph. Since the capacitive reactance equals the resistance, the total difference in phase angle between  $E_{R138}$  and  $E_{C123}$  is

$90^\circ$ . Similarly, the current through the b-d-e leg produces voltage drops that are in phase with the voltages in b-a-e leg as illustrated. It becomes apparent therefore that the voltage across d-a is  $90^\circ$  out of phase with that across b-e. For simplification of illustrating the phase-shifting function of the network, the source, having an impedance in the order of 125,000 ohms, was considered to comprise a constant current device, while the loads across which  $E_{V24}$  and  $E_{V23}$  appear were considered, in each case, infinite. Actually, the load circuitry modifies the amplitude of  $E_{V24}$  and  $E_{V23}$  to the extent that  $E_{V24}$  is approximately 3 db lower than  $E_{V23}$  rather than 6 db as would be indicated by the vectorial diagram.

c. The vectorial diagram and discussion above illustrate an instantaneous condition for a single applied frequency as it is used to drive the two phase rectifier circuits. The same shift is felt by all signals that appear at points b-e. At the same time, it is obvious that the signal applied to the plate of V23 through coupling capacitor C126 is  $180^\circ$  out of phase with the signal applied to the other plate of V23 through coupling capacitor C127, and similarly the signals coupled through C125 and C128 to the plates of V24 are  $180^\circ$  out of phase with one another. Therefore, when a single frequency is applied at the secondary terminals of T14 (as in the case where the afc gate tube is cut off by the squelch circuit) there is a cancellation of the output of one diode of the phase rectifier stage by the output of the other diode. Similarly, when the frequency of the local crystal oscillator is the same as that of the reconditioned carrier, the dc voltages developed at the junction of load resistors R146 and R147, as well as the junction of R140 and R141, cancel one another, and no output is delivered from phase rectifiers to the afc dc amplifier V25.

d. Whenever a frequency difference exists between the two signals that appear at the phase rectifier plates, each diode develops an output voltage proportional to the instantaneous difference between the voltages of the two applied signals. Of course, as in any rectifier circuit, each diode conducts only when the signal applied to its plate is positive relative to the cathode potential. The rate of change of the output of each phase rectifier is equal to the difference in frequency existing between the two applied signals. Hence an effective *beat note* is delivered from each phase rectifier to the following dc amplifiers. When the

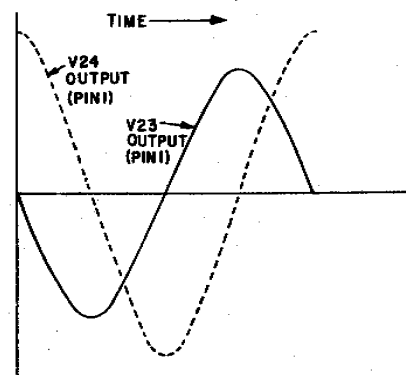
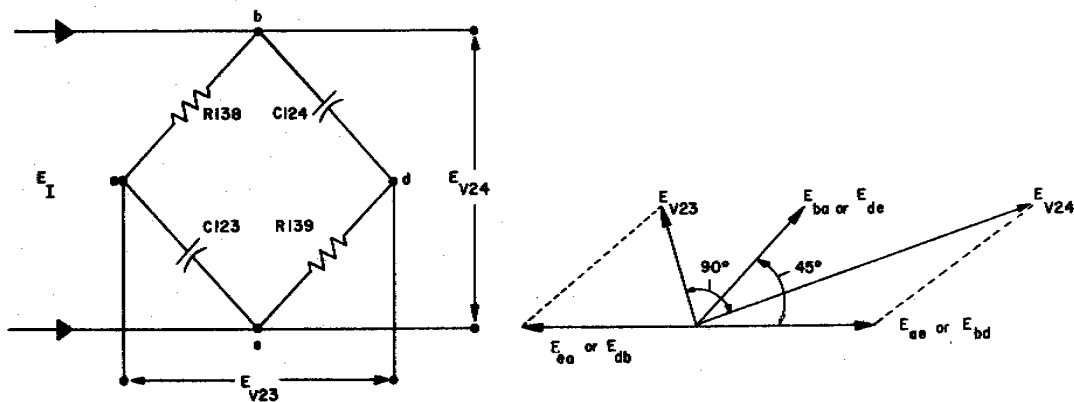
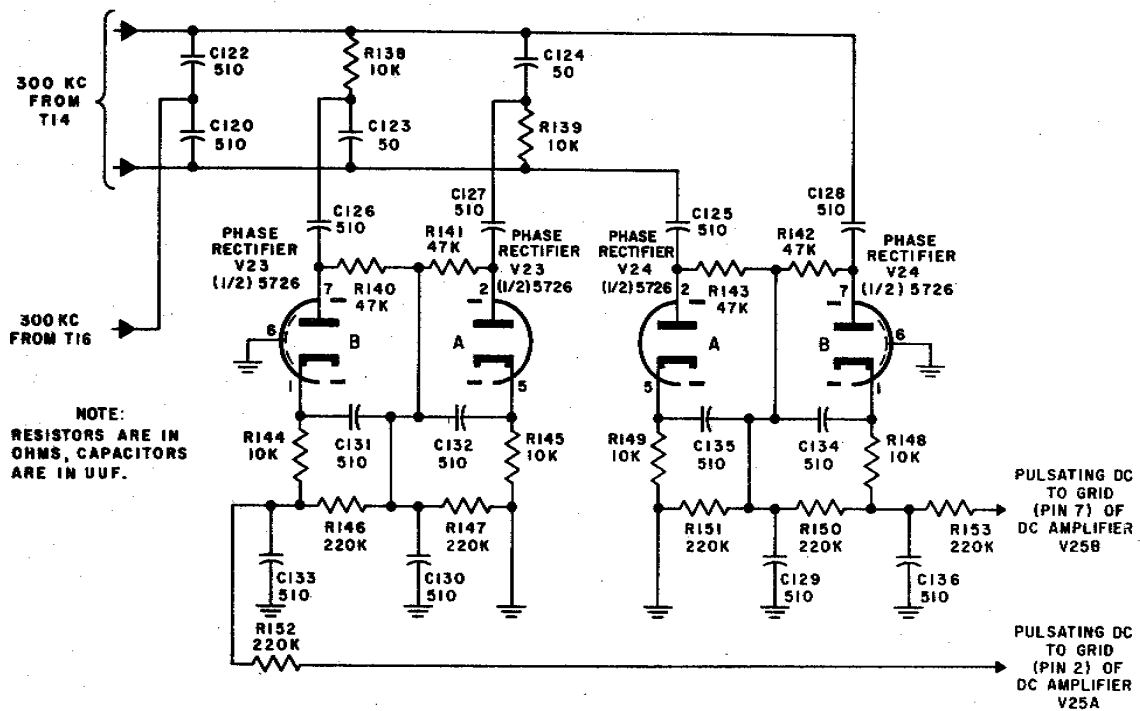


Figure 22. Phase-shifting network and phase rectifiers schematic diagram

difference frequency remains constant (that is, when no afc correction is being effected and the converted carrier frequency is no longer drifting), the output of each phase rectifier is a virtual sine wave or ac voltage. However, under conditions of drift and correction, the outputs may more accurately be considered pulsating dc voltages. Figure 49 shows the scope pattern that may be observed at the output of each phase rectifier and C, figure 22 indicates the respective output of each during any given instant during a theoretical cycle of error signal.

*e.* The output of V23 is delivered across the cathode load comprised of R144, R146, C131, R145, R147, and C132. Capacitors C130 and C133 are rf bypass capacitors located, respectively, in the plate and output circuits of the rectifier.

*f.* The operation of V24 being the same as that of V23, corresponding components are provided to perform equivalent functions to that described for V23. The output of V24 is delivered to pin 7 for , of afc ac amplifier V25. Although a slight dissimilarity in level exists between the output of V23 and that of V24, error signals of 1 cps (between converter carrier and local carrier oscillator frequencies) generate sufficient output from V23 and V24 to drive the afc dc amplifier through cutoff or conduct cycles, necessary to drive succeeding stages actuating the motor.

## 27. Afc Dc Amplifier

(fig. 23)

*a.* The output of rectifier V23 is delivered through grid-limiting resistor R152 to the grid (pin 2) of V25. The output of V24 is fed through R153 to the grid (pin 7) of V25. Tube V25 functions to amplify the voltage of the output of the two rectifiers (while maintaining their phase differential) prior to delivery of the signal to the motor drive stages. AFC switch S7 is in the cathode circuit of V25. When the switch is in the OFF position, cathodes of V25 are grounded through R160, thus cutting off the triode sections of the amplifier. In the ON position of S7, bias at the cathode (pin 3) is established through the dividing network formed by R155 and R184 while R157 and R156 furnish bias for the cathode (pin 8).

*b.* Resistors R154 and R158 are the plate-dropping resistors for the stage. The output signal from the plate (pin 1) is developed across divider R161 and R163 (fig. 24). The output signal from the plate (pin 6) is developed

across R159. Since the input signals are 90° out of phase (C, fig. 21), this phase relationship is preserved in the output from the afc dc amplifier (B, fig. 23). These output signals are delivered to amplifiers V26 and V29, respectively.

*c.* The small difference in voltage that exists at the grid of each section of the afc dc amplifier (par. 26*a*) disappears in the cutoff or conduct cycles of the amplifier so that drive to subsequent stages is virtually equal.

## 28. Afc Amplifiers-inverters

(fig. 24)

*a.* Two dual triodes, V26 and V29, are used to provide the push-pull output necessary to operate the motor drive stages of the afc circuit. The circuits are nearly identical and only the operation of V26 will be discussed in detail here.

*b.* The output from the plate (pin 1) of afc dc amplifier V25 (fig. 23) consists of a dc pulse recurring at the difference frequency between the output of tripler V35B (fig. 19) and afc gate V22 (fig. 19). The grid (pin 2) of V26 is biased negative through R163, and the application of a signal from the plate (pin 1) of V25 alternately cuts the tube off, then allows it to conduct, at a rate consistent with the difference frequency mentioned above. Simultaneously, a similar action takes place in V29A, except that the action of V29A takes place 90° out of phase with that in V26A. The lag or lead depends on the converted carrier delivered to the phase rectifiers being higher or lower than the standard signal.

*c.* The output from the plate (pin 1) of V26A developed across the plate load R165 is split. Part of this signal is delivered through R169 to the grid (pin 7) of V26. The remainder is fed to the grids of V28. The output from the plate (pin 6) of V26 is biased through R167 the same as V26A. It operates the same as the initial section, developing its output signal 180° out of phase with that produced by V26A. The output of (pin 6) V26 is fed to the grids of V27. Resistor R170 is the plate load resistor for section B of V26.

*d.* The outputs of the similar stage V29 are delivered to the grids of V30 and V31. However, they are 90° out of phase with the outputs of V26, as indicated in the diagram of B, figure 24.



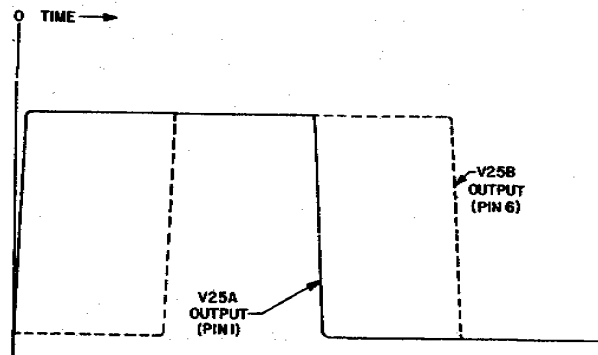
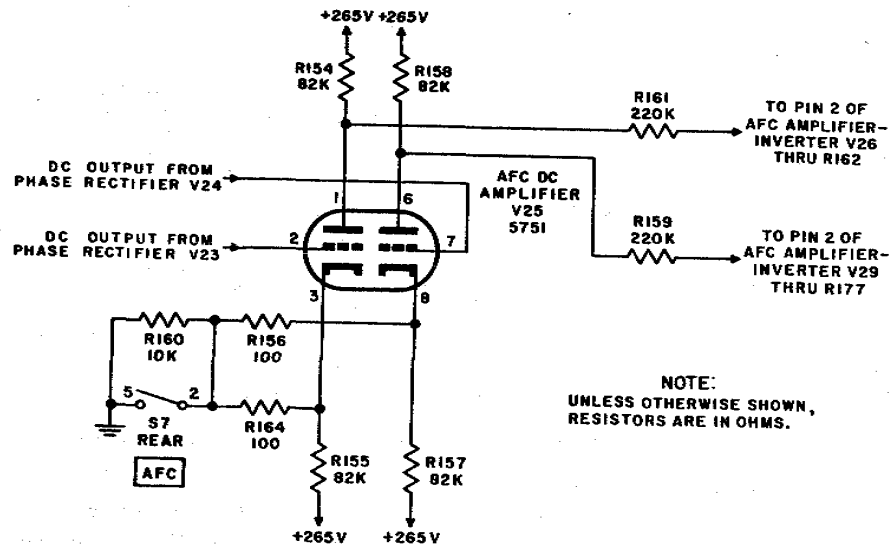


Figure 23. Afc dc amplifier, schematic diagram.

## 29 Afc Motor Drive Circuits

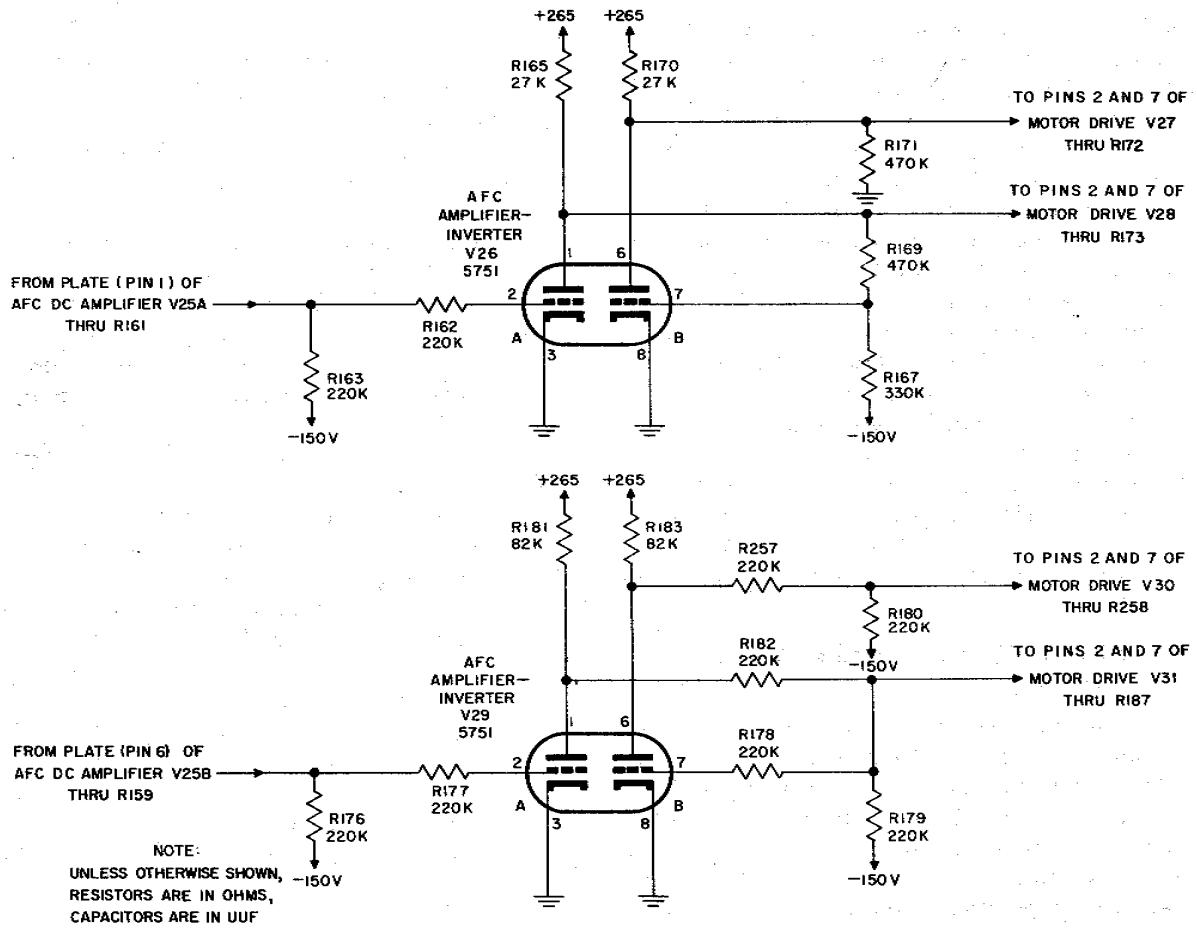
(fig 25)

a. Four dual triodes, V27, V28, V30, V31 comprise the afc motor drive stages. Tubes V28 and V31 function as the motor drive tubes with V27 and V30 acting as ballast tubes. Tubes V27 and V28 are fed from phase rectifier V23 through amplifiers V25A and V26 (figs 22, 23, and 24). Tubes V30 and V31 are fed from phase rectifier V94 through amplifiers V25B and V29.

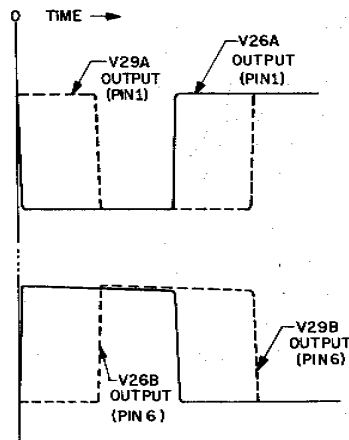
b. Tube V28 provides the signal that is fed to one motor winding (A-B). This signal is developed when a negative pulse is applied to the grid (pin 2) of V26. When this condition occurs V26B and V28 start to conduct. The conduction of V26B causes V27 to be held at cutoff.

When V28 (motor drive tube) conducts, cathode current is drawn from B+ through the winding (A-B) of the motor. The theoretical wave shapes diagrams of C, 22; B, 23; B, 24; and B, 25; figures 22C, 23B, 24B and 25B show the sequence of cutoff or conduct cycles and the maintenance of the 90° phase differential between the voltages applied to the motor windings. In B, figure 25, the conduction patterns of all cages of the afc circuitry for ease in visual analysis of circuit operation is shown.

c. With a positive pulse applied to the grid (pin 2) of V26A, V26B and V28 are cutoff. When this occurs, V27 (ballast tube) conducts drawing its cathode current from B+ through R253 and R254. The function of the ballast tube is to provide a balanced drain on B+ when the motor



A



B

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Figure 24. Afc amplifiers-inverters, schematic diagram.

drive tube is *not* conducting. Tube V30 and V31 operate in the same manner as V27 and V28. Tube V30 and V31, however, are fed from the signal that originates in phase rectifier V24. This results in the signal applied across the motor winding (C-D) fed from V31 being 90° out of phase with that delivered from V28. This 90° phase differential causes the motor to rotate. The lead and lag relationship between the signals applied across the two windings determines the direction the motor will rotate, and thus whether it corrects by raising or lowering the frequency of the heterodyne oscillator. Capacitors C137 and C138 are provided to reduce the peak voltages across the motor winding inductance. Switch S8 is located within afc unit Z1. It connects AFC DRIFT ALARM lamp I 2 and terminals 12 and 13 of TB2 to the 6.3-volt ac supply when motor B1 drives capacitor C13 to near the limit of its travel.

### 30. AGC SELECT Switch and SB AGC Control

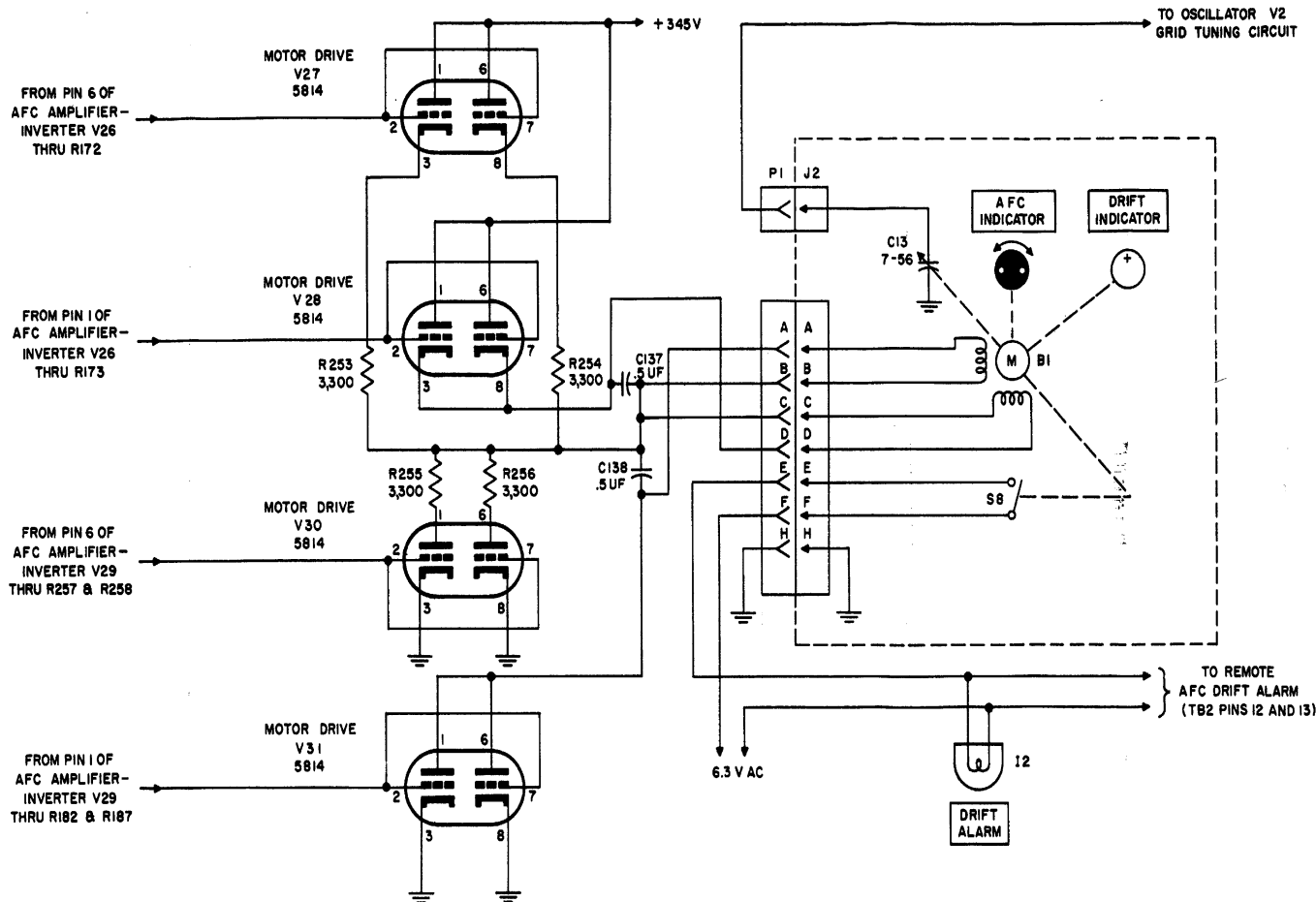
(fig. 26)

a. The maintenance of the correct amplitude of the audio output signal delivered from this converter to terminal equipment is critical. For this reason, control has been provided for the agc circuit of the receiver from the amplitude of the various parts of the transmitted signal *after* they have been separated in the filter circuits of the converter. This converter is intended for use in the reception of many different kinds of signals (par. 4). Most of these signals have an undesirable characteristic; they are unsatisfactory for use in the agc circuit of a receiver. One of the most common types of twin single-sideband signals has multiplex teletypewriter intelligence in one sideband and facsimile and a voice order wire in the other sideband. It is desirable to hold the teletypewriter intelligence at a constant amplitude. Since the receiver agc circuit *measures* the *overall* input signal to its if. section for the purpose of applying agc voltage, it is evident that the inconstant amplitude of the voice signal in one of the sidebands of the twin single-sideband signal will cause a strong and short-lined application of receiver agc voltage. This will result in the undesirable effect of suppressing and raising the teletypewriter intelligence directly with the variations in the amplitude of the voice intelligence. The problem therefore is one of selection. The agc voltage of the receiver must be controlled by the *most critical* component in the received signal to provide

for efficient operation by the system. The AGC SELECT switch provides a means of selecting this critical signal component for the application of agc voltage, *after the received signal has been separated by the converter filtering circuits.*

b. Switch S10 is a two-section rotary switch. Wafer A selects the various points in the converter circuit from which signals will be fed to the agc amplifiers and rectifiers. Wafer B merely activates or deactivates the agc circuit of the receiver, depending on whether or not the operator intends to use the facilities for controlling the receiver agc from the converter. The switch operates in the following manner:

- (1) In the REC position, contacts 1 and 2 of S10A connect the switch input to ground, while contacts 7 and 8 of S10A connect the first control grid (pin 1) of first agc amplifier V36 to ground. Contacts 7 and 11 of S10B connect the receiver agc output from terminal 9 of TB2 to the receiver through terminal 7 of TB2.
- (2) In the CAR position, contacts 3 and 1 of S10A connect the 100-kc carrier energy from voltage divider C94 and C95 to coupling capacitor C154. Contacts 9 and 7 of S10A connect the coupling capacitor C154 to the first control grid (pin 1) of first agc amplifier V36. Contacts of S10B connect the converter agc voltage from AGC TIME switch S11 to the receiver through terminal 7 of TB2.
- (3) In the LSB position, contacts 4 and 1 of S10A connect the output of converter upper sideband filter FL1 from the secondary of T4 to coupling capacitor C154 and variable voltage divider R250. Contacts 10 and 7 of S10A connect the arm of voltage divider R250 to the first control grid (pin 1) of first agc amplifier V36. Contacts 11 and 12 of S10B connect the converter agc voltage from AGC TIME switch S11 to the receiver through terminal 7 of TB2.
- (4) In the USB position, contacts 5 and 1 of S10A connect the output of lower sideband filter FL3 from the secondary of T7 to coupling capacitor C154 and variable voltage divider R250. Contacts 11 and 7 of S10A connect the arm of voltage



NOTE:

UNLESS OTHERWISE SPECIFIED,  
RESISTORS ARE IN OHMS,  
CAPACITORS ARE IN UUF.

OUTPUT OF	INPUT OF
V23	V25A
V24	V25B
V25A	V26A
V25B	V29A
V26A	V26B
V26B	V28
V29A	V29B
V29B	V31
V28	B1 (A-B)
V31	B1 (D-C)

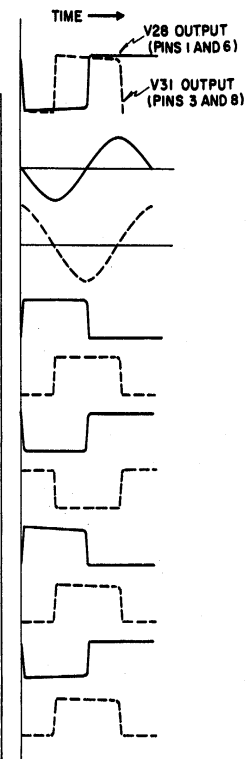


Figure 25. Afc motor drive circuit, schematic diagram.

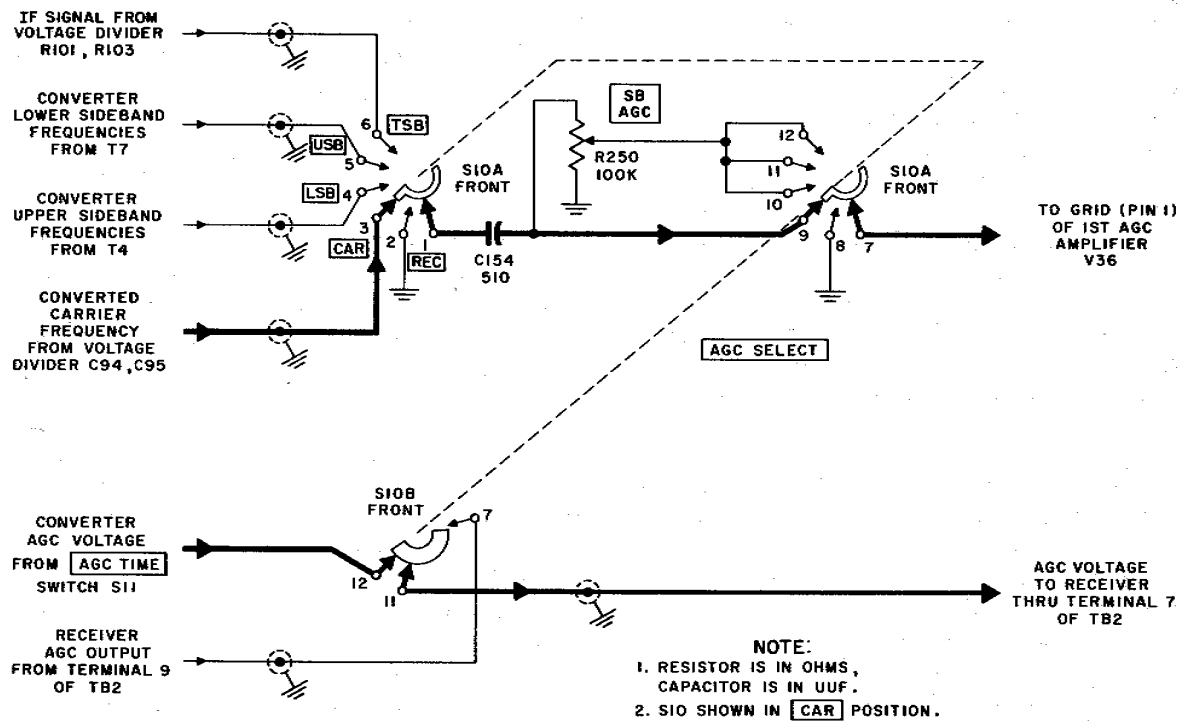


Figure 26. AGC SELECT switch and SB AGC control, schematic diagram.

divider R250 to the first control grid of first agc amplifier V36. Contacts 11 and 12 of S10B connect the converter agc voltage from AGC TIME switch S11 to the receiver through terminal 7 of TB2.

- (5) In the TSB position, contacts 6 and 1 of S10A connect the converter if. signal from the voltage dividing network (at the input to carrier if. amplifier V16) to coupling capacitor C154 and variable voltage divider R250. Contacts 12 and 7 of S10A connect the arm of voltage divider R250 to the first control grid (pin 1) of first agc amplifier V36. Contacts 11 and 12 of S10B connect the converter agc voltage from AGC TIME switch S11 to the receiver through terminal 7 of TB2.

c. SB AGC control R250 is a front panel control that provides compensation in the agc amplifying circuit for proper operation of the circuit for whatever type of sideband signal is being received by the converter. The control is used in the circuit only in the USB LSB, and TSB positions of S10. If a transmitter rated at a given fixed amount of power output, 1 kilowatt (kw), is used to

transmit all four types of signals at different times during the operating schedule, it results in a condition whereby 1 kw of power is being used to transmit a pure single-sideband signal, a single sideband signal carrier reduced, a twin single sideband signal carrier reduced, or an ordinary double-sideband signal. If the upper sideband frequency of all transmitted signals is used to carry a multiplex teletypewriter signal and becomes the most critical portion of the signal with respect to its amplitude, it is desirable for this portion of the signal to control the receiver agc voltage. The various types of signals named above have different percentages of the available transmitter power used in the transmission of the upper sideband portion of the signal. In the ordinary double-sideband signal, relatively little power is used in the transmission of the teletype writer intelligence. In the case of the pure, single-sideband signal, the entire power output (1 kw) of the transmitter is used in the transmission of the upper sideband frequencies. The other types of signals fall between these two extremes. The precise percentage of transmitter power devoted to the transmittal of teletypewriter intelligence is a function

of the degree of carrier suppression. The transmitter radiates 1 kw for the *overall* signal. It is the different *elements* of the signal that are attenuated or raised, depending on the type of signal being transmitted.

d. At the receiving end of the system, the receiver agc system *sees* a signal of the same average amplitude regardless of the type. In the converter, however, the situation is different. Here, a difference in the percentages becomes a difference in absolute values. Therefore, when a pure single-sideband signal is transmitted, the upper sideband frequency, as it appears at the output of converter lower sideband filter FL3 (fig. 11), and at the agc circuit, is of very great amplitude, because the entire radiated power of the transmitter is devoted to the transmission of this single frequency. In the case of a double-sideband signal, the output of FL3 is very small. Only about 25 percent of 1 kw available power is used to transmit this *specific* intelligence.

e. If no provision was made for the adjustment of the signal used to drive the agc circuit, the result would be the application of a great amount of agc voltage to the receiver in the USB, LSB, and TSB positions of S10, when a very great degree of carrier suppression at the transmitter was used. Very little agc voltage would be applied to the receiver when the carrier was not being reduced or when a twin single-sideband signal divided the available transmitter power between two sidebands. The application of agc voltage from the converter to the receiver would bear little relationship to the absolute agc voltage level required by the receiver to protect it from over-load and to properly compensate for the increasing or fading of the received signal, but would apply agc voltage dependent on the nature of the received signal and the degree of carrier suppression used to produce the incoming signal.

f. The function of R250 is to overcome this undesirable effect. It enables the operator to adjust the voltage fed to first agc amplifier V36 in accordance with the type of signal the converter is receiving. Wherefore, for signals that use a relatively high degree of carrier suppression, R250 is adjusted to attenuate the input to V36 by a greater amount. For signals that have a lesser degree of carrier suppression, R250 is adjusted to attenuate the input to V36 by a lesser amount. The normal setting of the SB AGC, control (R250) for the

usual 20-db carrier reduction of the transmitter is 7.5. Do not attempt to use this adjustment as an audio volume control. Audio-output levels are established as outlined in paragraph 68. The adjustment of CARRIER COMPENSATOR control R112 (fig. 16) takes care of variations of carrier amplitude when the AGC SELECT switch is in the CAR position. A balanced system is thereby achieved to enable the converter to apply agc voltage to the receiver in an amount compatible with the amplitude variations displayed by the received signal.

## 31. AGC Circuit

(fig 27)

a. The output of S10A (par. 30) is delivered to the grid of a sharp cutoff pentode, V36, which amplifies the signal and delivers it to a triode amplifier V37A, which further amplifies the signal. The output of V37A is fed to the grid of the second section of the dual triode, V37B, which has a common grid and plate, thereby acting as a rectifier. The dc output of this rectifier is used as a control signal, delivered from the converter to operate the agc system of its associated receiver.

b. The output of S10A is fed to the first control grid (pin 1) of V36. The amplifier is biased at the cathode by R219, which is bypassed by C155. The plate is decoupled from the high-voltage supply by R221 and C157, the screen by R220 and C156. Resistor R222 is the plate load resistor for the stage.

c. The output of V36 is coupled through C158 and is applied across resistor R225 to the grid of second agc amplifier V37A. Amplifier V37A further amplifies the signal that is coupled through dc blocking capacitor C160 to the plate of V37B. The cathode of V37A is biased by R226, which is bypassed by C161. Inductor L2 is used to provide the plate load for V37A, while not decreasing the applied plate potential, to permit greater signal drive to agc rectifier V37B. Resistor R223 and C159 decouples the power supply from the plate circuit of V37A.

d. Agc rectifier V37B is a triode, which is connected as a diode. The cathode of V37B is biased through resistors R230, R232, R233, R234 and control R231. The fixed resistors form two dividing networks separated by R231, which is the AGC THRESHOLD adjustment. One end of R231 taps off at the junction of R230 and R233, which are series connected between the power supply

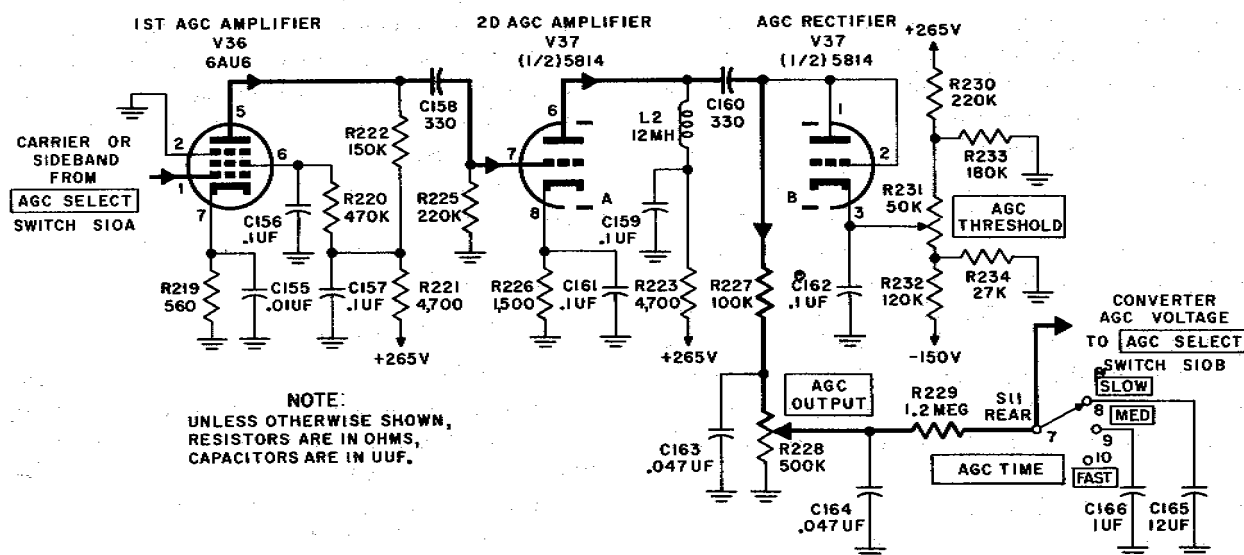


Figure 27. Agc circuit, schematic diagram.

high-voltage and ground. The other end of the control taps off the junction of R232 and R234, which are series-connected between the B- power supply and ground. The cathode of V37B is connected to the arm of the control. As the arm of R231 is varied toward the junction of R230 and R233, the cathode of V37B becomes more positive. As the arm is varied toward R232 and R234, the cathode of V37B becomes more negative. Actually, since R231 is connected between the B+ and B- supplies in this manner, the cathode of V37B may be varied from -8 volts to +35 volts. This design consideration enables the converter to be adapted for use with receivers that have a variety of characteristics in their agc circuits. Instructions for adjusting R231 are given in paragraph 67. Capacitor C162 is the bypass capacitor for the cathode bias network of V37B.

e. The dc voltage output of V37B is fed through isolating resistor R227 and applied across R228, which is the AGC OUTPUT adjustment. The negative potential at the arm of R228 varies with the condition of V37B. The more V37B conducts, the more negative the potential at the arm of R228 becomes. This change in potential is reflected through isolating resistor R229 to the agc system of the receiver, thus controlling the application of agc voltage in the receiver. The function of R229 and the arm of R228 is held at effective rf ground potential by C164. Resistor R228 is adjusted to balance the agc voltage output with the receiver agc system. Instructions for

adjusting R228 also are given in paragraph 67.

f. The AGC TIME switch, S11 is provided to enable different times of reaction to be selected for operation of the agc circuit with various types of signals. The switch selects capacitors which, when placed in the dc output circuit of the agc amplifying-rectifying section of the converter, charge and discharge to slow up the effect of the agc circuit. The switch has three positions: SLOW, MED, and FAST. In the FAST position, the output of the agc circuit is connected directly to the receiver and very little time delay (caused by C163 and C164) across R227 and R228 is introduced. In the MED position, the output of the agc circuit is connected through terminals 7 and 9 of S11 to the ungrounded side of C166. Capacitor C166 is a 1.0-uf capacitor giving the circuit a time constant of 1 second. In the SLOW position, the output of the agc circuit is connected through terminals 7 and 8 of S11 across C165. This capacitor (12 uf) gives the circuit a delayed reaction of approximately 15 seconds.

## 32. Monitor Circuit

(fig. 27)

a. The MONITOR headset jack (J3) on the front panel of the converter is made available as an aid in various tuning and testing procedures. The audio output of either converter channel A or B may be selected by means of the MONITOR

switch (S3) on the front panel of the equipment to be delivered to the monitor output amplifying system. Two amplifiers are used in the circuit, triode V9A and power pentode V10 which is operated as a cathode follower.

b. The audio output of channel A, as it appears at terminal 1 of T5 (fig. 14), is fed to terminal 8 of S3. The audio output of channel B, as it appears at terminal 1 of T8, is delivered to terminal 10 of S3. These are selected in the A and B positions of the MONITOR switch on the front panel of the equipment. Terminal 7 of S3 is the wiper contact of the rotary switch through which the selected audio signal; B fed to the grid circuit of V9A. In the OFF position of the MONITOR switch, the grid circuit of V9A is connected through terminal 9 of S3 to ground.

c. The selected output of S3 is fed through the voltage dividing network formed by R49 and C50 and applied across MONITOR GAIN control R248. The volume of the output from MONITOR jack J3 is adjusted by MONITOR GAIN control R248. Cathode bias for V9A is developed across R50 which is bypassed by C51A. Resistor R55 is the plate-dropping resistor for the stage.

d. The output of V9A is coupled through C55 to the first control grid (pin 1) of V10. Tube V10 functions as a cathode follower output stage. The pentode is connected as a triodes having a common plate and screen which are decoupled from the high-voltage power supply by R61 and

C57. The grid resistor, R57, is returned to the low potential end of cathode-biasing resistor R58. The load for V10 is formed by parallel-connected resistors R59 and R60, in series with R58. The signal developed by V10 across this load is coupled through C56 to the MONITOR jack on the front panel of the converter where it is made available to a headset or any other suitable audio reproducing device.

### 33. VU METER Circuit

(fig. 29)

a. A meter, calibrated in volume units (vu), is mounted on the front panel of the equipment to provide an indication of the converter audio-output level delivered from channel A or B. A reading of 0 vu on the meter indicates a converter audio-output level of 1 milliwatt into a 600-ohm line.

b. Through VU SELECT switch (S4) on the control panel, the output of channel A or B is applied to vu meter amplifier V9B or the VU METER circuit is turned off. In the A position of S4, the audio output of channel A, as it appears at terminal 3 of T5 (fig. 14), fed through contacts 8 and 7 of the rotary switch to the grid circuit of V9B. In the OFF position, a blank contact (9) is used. In the B position, part of the audio output of channel B is taken off terminal 3 of T6 and

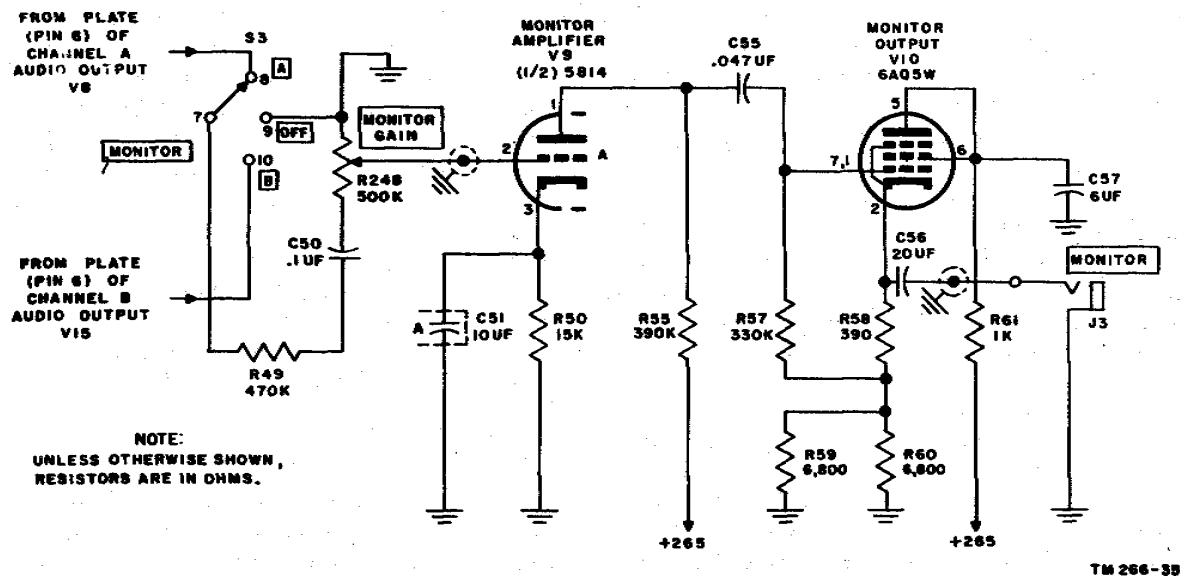
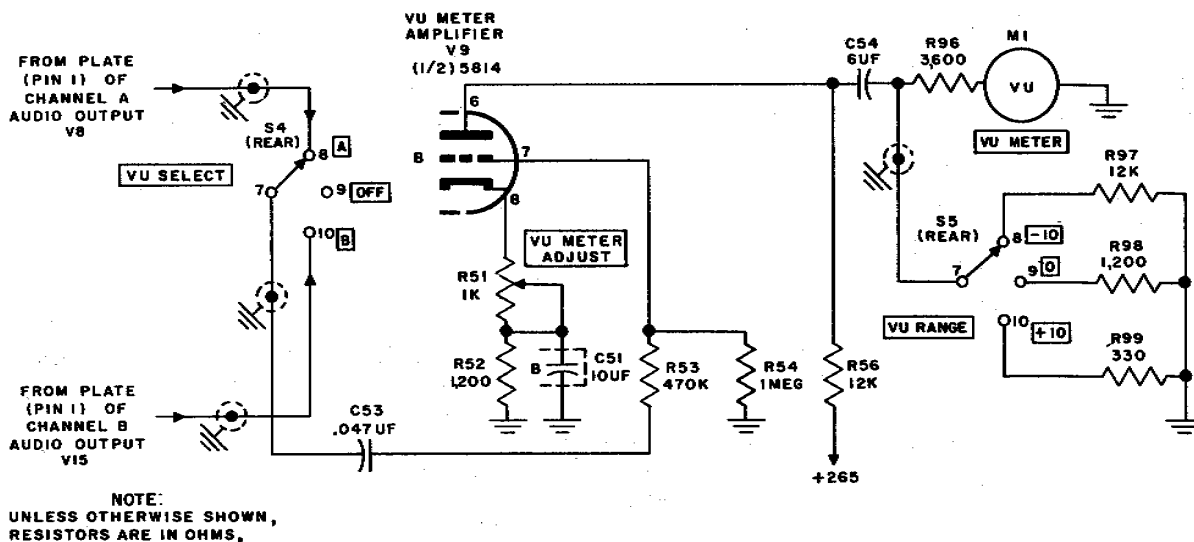


Figure 28. Monitor amplifier and output circuit, schematic diagram.





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Figure 29. VU METER circuit, schematic diagram.

fed through contacts 10 and 7 of S4 to the grid circuit of V9B. The signal delivered through S4 is coupled through C53 and applied across the divider formed by R53 and R54 to the grid of triode amplifier V9B. This amplifier is biased by resistor R52 and control R51, which are bypassed by C51B. VU METER ADJUST control R51 varies the bias on the cathode of V9B, thereby calibrating the meter.

c. The output of V9B is coupled through C54 and applied across resistor R96 and meter M1. The meter is connected as a voltmeter with the different multiplying resistors connected between the plate circuit of V9B and ground. Depending on the position of VU RANGE switch S5, either R97, R98, or R99 is placed in the plate circuit of V9B as a shunt to provide the proper meter sensitivity. In the +10DB position of S5, R99 is placed in the circuit. In the 0 DB and -10 DB positions, R98 and R97 respectively, are selected as shunts by S5.

### 34. Power Supply

(figs. 30 and 40)

a. *General.* The power supply converts the primary ac power source to voltages that satisfy the circuit requirements of the converter. The converter is operated from primary power sources of 105 through 125 or 210 through 250 volts ac, 50 to 60 cps. The converter power supply converts the primary voltage to 6.3 and 5 volts ac for filament and indicator lamp circuits; +345 volts dc

(unregulated) for the motor drive circuits; +265 volts dc (regulated) for the plate circuits; and -150 volts dc (regulated) for the bias circuits. The dc supplies are regulated to stabilize the operating conditions of the electron tubes in the converter. Without voltage regulation, electrode voltages would tend to fluctuate in response to line voltage variations, as well as changes in load. The two dc supplies use different modes of voltage regulation. The less complex circuit used in the low-current bias supply would not operate satisfactorily in the high-current plate supply. Hum and spurious signals on the power line are isolated from the secondary windings of the power transformer by an electrostatic shield grounded through the transformer case.

b. *Power Input Circuit.* The line voltage is impressed across the primary winding of power transformer T17 after passing through PWR IN receptacle J5, VOLTAGE SELECT switch S12, and circuit breaker CB1. The circuit breaker is located on the front panel and serves as the converter power switch. Circuit breaker CB1 is a three-wire device, two branches of which contain magnetic tripping elements. Circuit breaker CB1 will open the primary power circuit when the primary current exceeds the rating of the magnetic trip in use. When S12 is in the 230V position, the entire primary winding of T17 is connected to the line through the low-current element of CB1.



the 115V position, S12 connects only one-half of the primary winding of T17 to the line through the high-current element of CB1. Overload protection is provided therefore whether the converter is operating from a 105- through 125-volt or 210- through 250-volt source. The third leg of CB1 does not contain a magnetic trip but simply connects one side of the incoming line to the No. 1 terminal of the primary of T17. This leg is disconnected automatically when either of the other legs trip, so that power is removed from both sides of the transformer primary when a short circuit occurs in the converter. Additional taps on the primary of T17 provide for line voltages in the 105- through 125-volt and 210- through 250-volt ranges. The 115 volts ac is tapped off one-half of the primary, and is fed to blower motor B2 through J6 and P3.

*c. Filament Supply.* Transformer T17 has six secondary windings, four of which are used to supply filament voltages to the various electron tubes in the converter. The filament supply voltages of the various secondaries are distributed in the following manner:

- (1) Terminals 12 and 13 supply 5 volts ac to the filaments of rectifier tubes V38 and V39.
- (2) Terminals 17 and 18 supply 6.3 volts ac to the filaments of regulator tube V40.
- (3) Terminals 19 and 20 supply 6.3 volts ac to the filaments of dc amplifier V41, motor drive tubes V27 and V28, and the front panel indicator lamp I 3.
- (4) Terminals 24 and 26 and center tap terminal 25 supply 6.3 volts ac to the filament of rectifier tube V43 and all the filament and indicator circuits located in the converter drawer assembly except motor drive tubes V27 and V28.

*Note.* Tubes V38, V39, V40, V41, V42, and V43 are located on the converter power supply chassis (fig. 40).

*d. 265-Volt Source.* The center-tapped power transformer secondary winding terminating on terminals 14, 15, and 16, supplies high voltage to rectifiers V38 and V39. The two plates of the individual rectifiers are connected together, thus doubling the current rating of each tube. The tubes and the high-voltage secondary are connected to form a full-wave rectifier. The center tap (terminal 15) of the high-voltage secondary winding is grounded and the pulsating dc is taken from one side of the rectifier filament circuit. The high-

frequency components of the pulsating dc are attenuated by the low-pass filter formed by L4, C167, and C168. The filtered dc is fed to the 265-volt regulator stage.

*e. 265-Volt Regulator.* Regulator V40, dc amplifier V41, and voltage reference tube V42 stabilize the converter plate circuit supply voltage. Regulator V40 functions as a controlled resistance connected between the 265-volt source and the converter circuits making up the power supply load. The following is a step-by-step analysis of the compensating action which tends to make the plate supply voltage immune to line voltage variations of approximately  $\pm 5$  percent.

- (1) An increase in line voltage results in an increase in the output of rectifiers V38 and V39.
- (2) The voltage across the load will also increase, until compensated by a rise in, the controlled resistance represented by the plate-cathode resistance of V40.
- (3) A sample of the load voltage is fed to the grid of dc amplifier V41. The cathode voltage of V41 is fixed by a gaseous voltage regulator, voltage reference tube V42.
- (4) The increase in voltage at the grid of V41 is amplified and inverted, and appears at the plate as a decrease in positive voltage.
- (5) The grids of regulator V40 are connected to the plate of V41. The decrease in voltage at the plate of V41 has the effect of increasing the grid bias on V40, increasing the plate-cathode resistance of V40.
- (6) The load current through the increased plate-cathode resistance of V40 results in a greater voltage drop there, and less voltage is delivered to the load.
- (7) The voltage delivered to the converter B+ supply is held constant, regardless of whether the line voltage should increase or decrease. Current balancing resistors R238 and R239 connect the plates (pins 2 and 5) of regulator tube V40 to the filtered output of rectifiers V38 and V39 and act as parasitic suppressors. The cathodes of V40 are connected to the load. A sample of the voltage across the load is taken from the movable contact of REGULATOR CONTROL R245, a part

of voltage divider R244, R245, and R246. The sample voltage is fed to the grid (pin 1) of dc amplifier V41. The cathode bias of V41 is fixed by the series combination of voltage reference tube V42 and resistor R241. The screen voltage of V41 is held fairly constant by resistors R235 and R236. When an increase in line voltage causes a temporary increase in voltage across the load, the grid (pin 1) of V41 will become more positive. A higher plate current flows as a result of this reduced bias. There is a greater drop across R240, the plate load resistor of V41, and the voltage at the plate decreases. The grids of V40 (pins 1 and 4) are connected through parasitic suppressors R242 and R243 to the plate of V41. A drop in voltage at the plate of V41 results in an increase in grid bias at V40. Thus, the plate-to-cathode resistance of V40 increases for an increase in line voltage, and the voltage across the load is restored to its original value. The regulated output voltage will seek an original value determined by the adjustment of R245, regardless of the direction of the line voltage change. The sample voltage applied to the grid (pin 1) of dc amplifier V41 lags behind the immediate line voltage change, because of the action of C171 and C172. If the time delay were not introduced, the corrective action would be regenerative. The combined effect of

C172, and the plate-cathode resistance of V40, is that of a low-pass filter which further smoothes the output of the rectifiers, as does the action of the regulator system.

*f. -150-Volt Source and Regulator.* Rectifier V43 and voltage regulator V44 supply the converter with a stabilized source of bias voltage. Stabilization of the bias source is necessary to hold bias potentials at optimum values that are independent of line-voltage fluctuations. The high voltage secondary winding of T17, terminals 21, 22, and 23, supplies high voltage to rectifier V43. The high-voltage winding of V43 are connected to form a full-wave rectifier. The cathode of V43 is grounded, and pulsating dc is taken from the center tap (terminal 22) of the high-voltage winding. The pulsating dc is then fed to C169 L5 and C170, and low-pass filter which smoothes out the line frequency components of the rectifier output voltage. The negative output voltage is stabilized at 150-volt by the action of gaseous voltage regulator V44 and series-dropping resistor R237. In a gaseous voltage regulator with a suitable series dropping resistor, the terminal voltage of the regulator will remain constant, with fairly large variations of input voltages. An increase in line voltage causes an increase in rectifier output voltage. The increase in rectifier output is absorbed as a voltage drop across R237 because of increased current through R237 and V44 which attempts to maintain -150 volts across its elements. Regulating action that results from a decrease in line voltage causes the circuit to operate in the opposite manner.

## CHAPTER 3

### TROUBLESHOOTING

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

#### 35. Troubleshooting Procedures

*a. General.* The first step in servicing a defective piece of electronic equipment is to localize the fault. Localization means tracing the fault to the *major circuit* responsible for the abnormal operation of the set. Isolation means tracing the fault to the defective *part* responsible for the abnormal condition. Some faults such as burned-out resistors or capacitors and shorted transformers often can be located by sight, smell, and hearing. The majority of faults, however, must be isolated by *checking voltages and resistance*.

*b. Procedure.* The tests listed below aid in isolating the sources of trouble. To be effective, the procedure should be followed in the order given. Servicing should cause no further damage to the equipment. First, trouble should be localized to a single stage or circuit; then the trouble may be isolated within that stage or circuit by visual inspection, voltage and resistance measurements and signal substitution.

- (1) *Visual inspection.* The purpose of visual inspection is to locate any visible trouble such as loose, broken, or charred parts. Through this inspection alone, the repairman frequently may discover the trouble, or determine the stage in which the trouble exists. This inspection is valuable in avoiding additional damage to the equipment which might occur through improper servicing methods *and* in forestalling future failures.
- (2) *Resistance measurements.* These measurements (par. 42) prevent further damage to the equipment from possible short-circuits. This test gives an indication of the condition of the filter circuits; therefore, its function is more than preventive.

- (3) *Troubleshooting chart.* The symptoms listed in this chart (par. 41) will aid greatly in localizing trouble.
- (4) *Operational test.* The operational test (par. 40) is important because it frequently indicates the general location of trouble. In many instances, the information gained will determine the exact nature of the fault. To use this information fully, all symptoms must be interpreted in relation to one another.
- (5) *Signal substitution and signal tracing.* The principal advantage of the signal substitution and signal tracing method is that it usually enables the repairman to localize a trouble accurately and quickly to a given stage when the general location of the trouble is not immediately evident from other tests.
- (6) *Intermittent troubles.* In all these tests, the possibility of intermittents should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring the set. It is possible that the trouble is not in the converter, but in the installation (cabling to receivers, power cable, or carrier terminal equipment connections) or the trouble may be caused by external conditions. In this event, test the installation, if possible.

#### 36. Troubleshooting Data

The material supplied in this manual will help in the rapid location of faults. Consult the following trouble shooting data.

Fig.	Par.	Description
44	----	Converter removal and disassembly.
46	----	Afc unit, exploded view.
49	----	Afc circuit oscilloscope test points.
50	----	Alinement and adjustment points on converter

## 36. Troubleshooting Data-Continued

Fig.	Par.	Description
62	-----	MIL-STD resistor color code.
63	-----	MIL-STD capacitor color code.
64	-----	Tube socket voltage and resistance data chart.
65	-----	Resistor and capacitor board voltage and resistance chart.
66	-----	B+ and B- voltage distribution diagram.
67	-----	Converter, schematic diagram.
68	-----	Converter, Wiring diagram.
	37	Test Equipment required for field maintenance.
	39	Checking B+ and B-for shorts.
	30	Operational test.
	41	Troubleshooting chart.
	42	Dc resistances of transformers, coils, and filters.
	43	Signal substitution and signal tracing notes.
	45	Replacement of parts.
	46	Disassembly and reassembly of afc unit Z1
	47	Relay adjustments.
	48	Troubleshooting afc circuit.
	50-68	Alinement

## 37. Test Equipment Required for Field Maintenance

The test equipment recommended for trouble-shooting Single Sideband Converter CV-157/URR is listed below. The manuals associated with the test equipment also are listed.

Test equipment	Technical manual
Tool Equipment TE-113-----	-----
Tool Equipment TE-114-----	-----
Multimeter TS-352B/U-----	TM 11-5527A
Signal Generator AN/URM-25-----	TM 11-5551
Electronic Multimeter ME-6A/U-----	TM 11-5549
Electron Tube Test Set TV-2/U-----	TM 11-2661
Electron Tube Test Set TV-7/U-----	TM 11-5083
Frequency Meter FR-67/U-----	TM 11-2698
Audio Oscillator TS-382A/U-----	TM 11-2684A
Sound Analyzer TS- 615/U-----	TM 11-5032
Oscilloscope OS-8A/U-----	TM 11-1214
Variable Transformer CN-16A/U-----	-----

## 38. General Precautions

(figs. 31-36)

Whenever the converter is serviced, observe the following precautions carefully:

- a. When removing the drawer assembly from the base

assembly (fig. 44), be careful not to place a strain on the interconnecting cabling.

- b. Be careful when the drawer assembly is extended; dangerous voltages are exposed.

- c. Careless replacement of parts often makes new faults inevitable. Note the following points:

- (1) Before a part is unsoldered, note the position of the leads (figs. 32-35). If the part, such as a transformer, has a number of connections, tag each of the leads to it.
- (2) Be careful not to damage other leads by pulling or pushing them out of the way.
- (3) Do not allow drops of solder to fall into the set; they may cause short circuits.
- (4) A carelessly soldered connection may create a new fault. It is important to make well-soldered joints because a poorly soldered joint is one of the most difficult faults to find.

## 39. Checking B+ and B- for Shorts

- a. *General.* Trouble within the converter may be detected by checking the resistance of the high voltage circuits before applying power to the equipment, preventing damage to the power supply. Make the following checks before attempting to put the converter in operation. The front panel power switch must be in the OFF position before any of these measurements are attempted. The setting of other controls and adjustments is unimportant.

- b. *Unregulated B+ Test.* The measured resistance between unregulated B+ and ground should be 130K. A convenient test point is the high potential terminal of R238 (figs. 30 and 41). The high potential end of R238 is nearest the bottom of the power supply chassis. The unregulated part of the +265-volt supply is isolated from the load by the plate-cathode resistance of regulator V40. The plate-cathode resistance of V40 approaches infinity when the converter is turned off. Thus, resistance measurements at this point will only show up defects in components at the input to regulator V40.

- c. *Regulated B+ Test.* The value of the resistance measured between regulated B + and ground should be 23K. A convenient test point is the high potential terminal of C172, mounted in the converter, base assembly (fig. 38). The high potential terminal of C172 may be identified by the two red wires. This resistance measurement tends to reveal defects in the components connected to the output of regulator V40 but will not reveal

defects in components connected the input side of V40.

*d. Regulated B- Test.* The measured resistance between regulated B-test point and ground should be 25K. The terminal of C170 to which the two violet-white wires are connected is a convenient test point. The capacitor is mounted in the base assembly and is located near the rear left corner of the assembly (fig. 38).

*e. Significance of Resistance Measurements.* If any of the above resistance values drop to a few hundred ohms or less, a short in the wiring, rectifier tubes, or filter capacitors may be suspected. Any other change in resistance values must be analyzed critically by referring to the B+ and B-voltage distribution schematic (fig. 66). Leaky or shorted capacitors, interelectrode electron tube shorts, or wiring or resistor defects could cause deviations from the normal resistance values. Many component defects will not show up as a change in resistance value at the test point because of the magnitude of the isolation or load resistors in the circuit. Occasionally, circuits that short with high voltage applied will not appear shorted to the low voltage of an ohmmeter. Other shorts occur only when the tubes are hot and can only be determined by other tests.

## 40. Operational Test

*a.* If the converter is connected with its associated components for normal operation, refer to the set manual to operate the equipment.

*b.* If the converter is being checked independently of the system, perform the following procedures to make it ready for operation:

- (1) To simulate an input signal, connect Signal Generator AN/URM-25 at IF. INPUT jack J1. Set the generator to deliver 455-kc output at 10,000 microvolts (uv) modulated 30 percent

with a 1,000-cps note. This input will simulate a double-sideband signal input to the converter, which is satisfactory for the operational testing of the converter.

- (2) To simulate an output load, connect four 300-ohm resistors across the terminals of TB1. One between terminals 1 and 2, one between terminals 2 and 3, one between terminals 4 and 5, and one between terminals 5 and 6.

*c.* Tracking the afc circuit may be checked by *slowly* varying the converter VERNIER control while monitoring either channel A or B and observing the DRIFT INDICATOR control. The pitch of the tone in the monitored channel should remain the same and the DRIFT INDICATOR should track, showing the same deviation frequency as the VERNIER control is varied over its range.

*d.* Connect the headset (or other auditor monitor) to the channel A output and then to the channel B output on TB1 (terminals 1 and 3 for A; 4 and 6 for B). A strong output indicates each channel is functioning.

## 41. Troubleshooting Chart

The following chart is supplied as an aid in locating trouble in the converter. The chart lists the symptoms that the repairman observes while making a few simple tests with the equipment connected as instructed in paragraph 40. The chart indicates how to localize trouble quickly to the input, sideband amplifiers, carrier amplifiers, demodulators, audio amplifiers, limiters, agc, afc, or power supply sections of the converter. Once the trouble has been localized to a stage or circuit, a tube check and voltage and resistance measure meets of this stage or circuit ordinarily should be

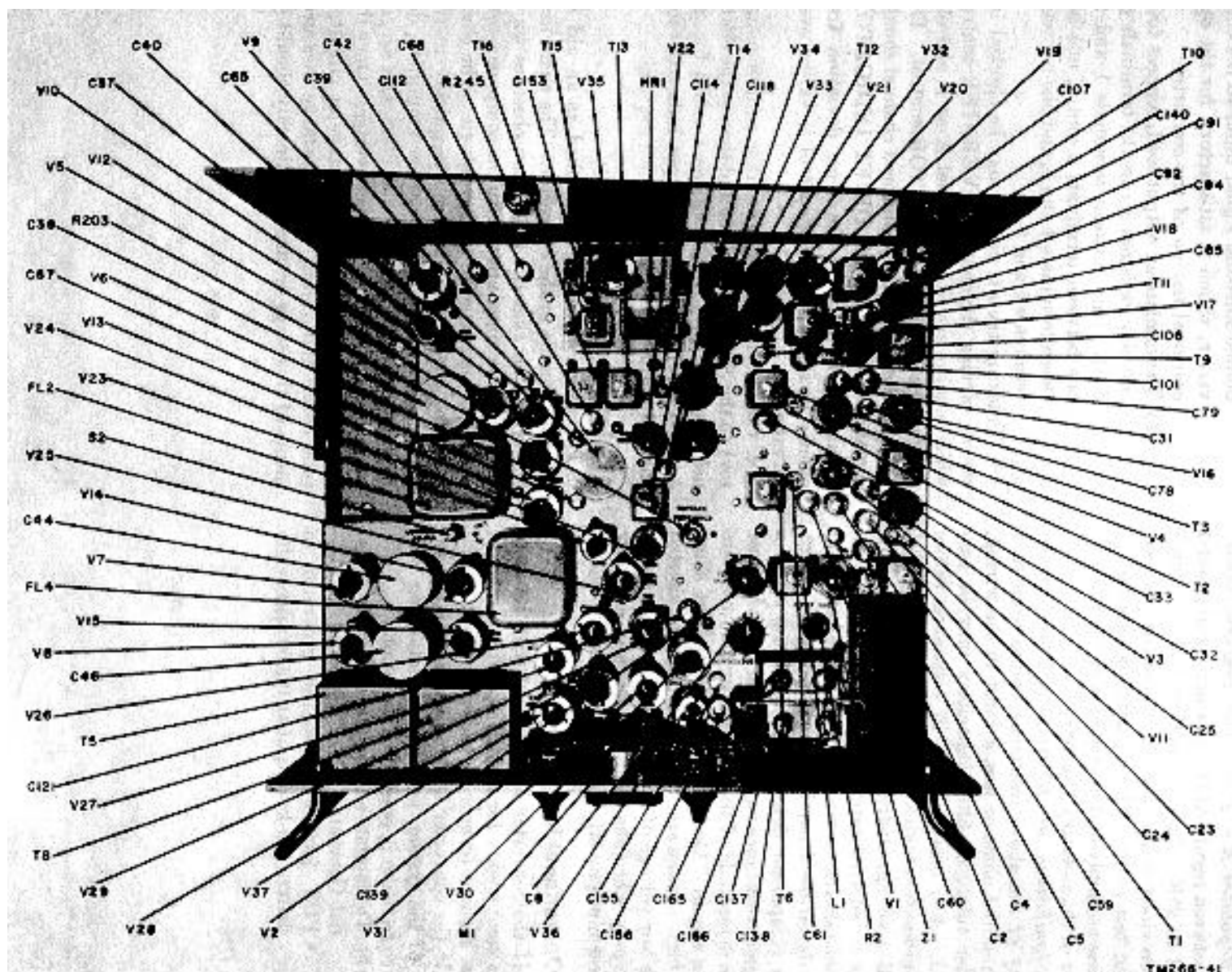
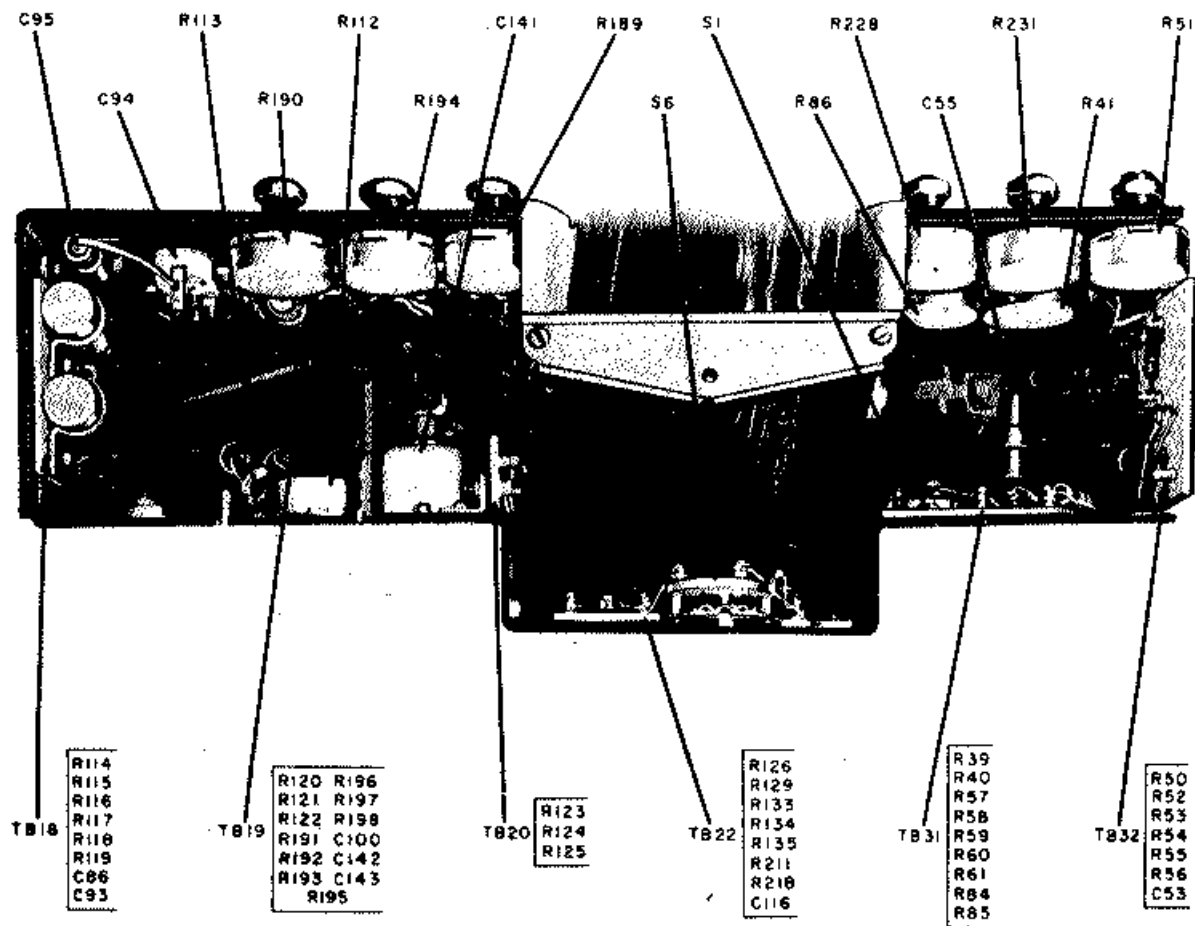
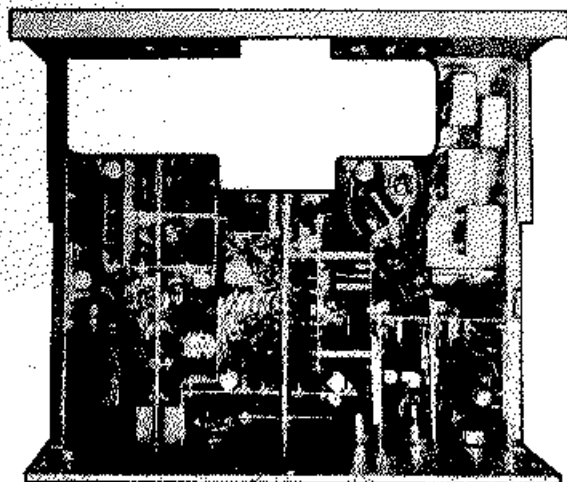


Figure 31. Converter drawer assembly, top view.





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Figure 32. Converter drawer assembly, bottom view (rear section).

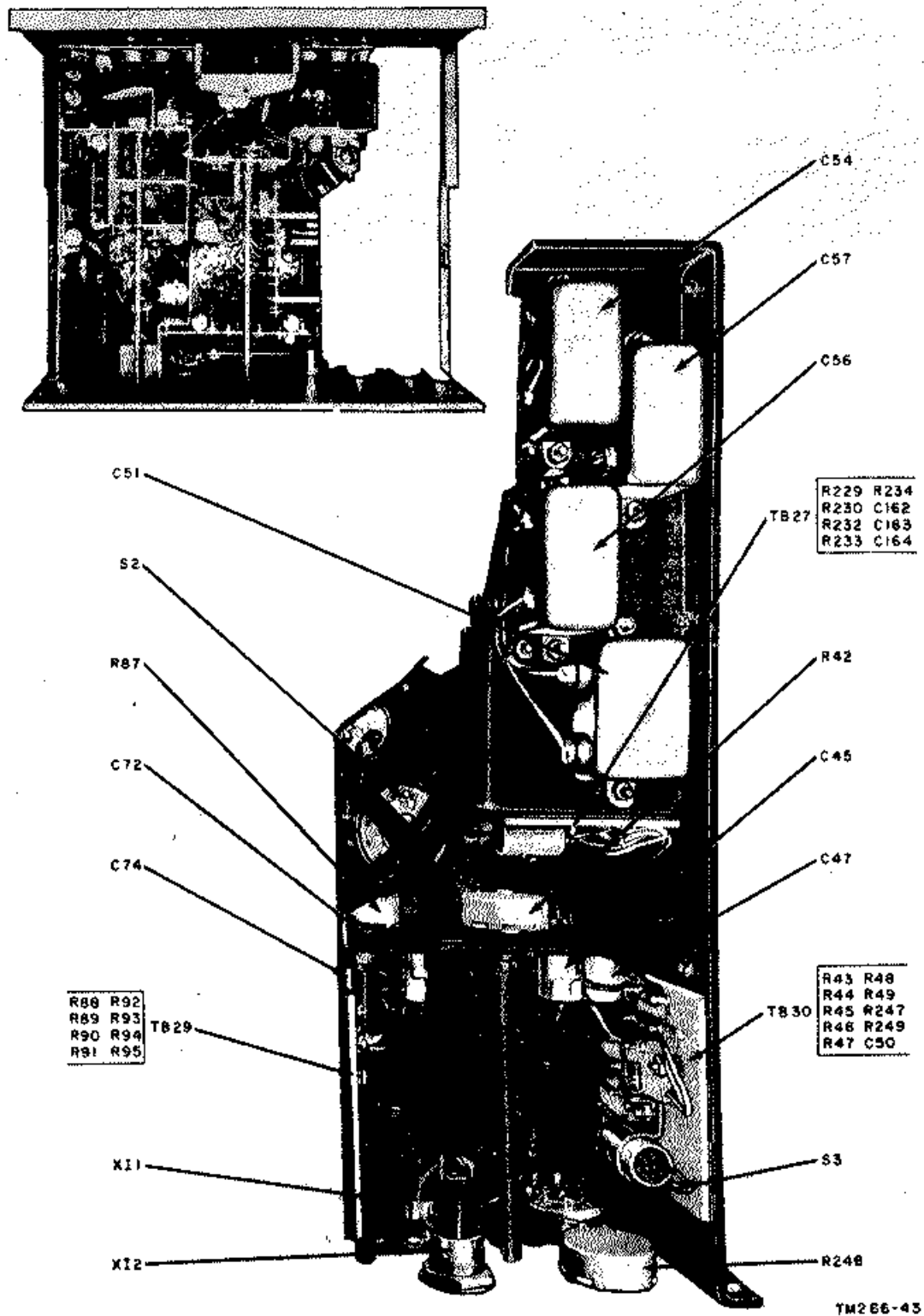


Figure 33. Converter drawer assembly, bottom view (left section).

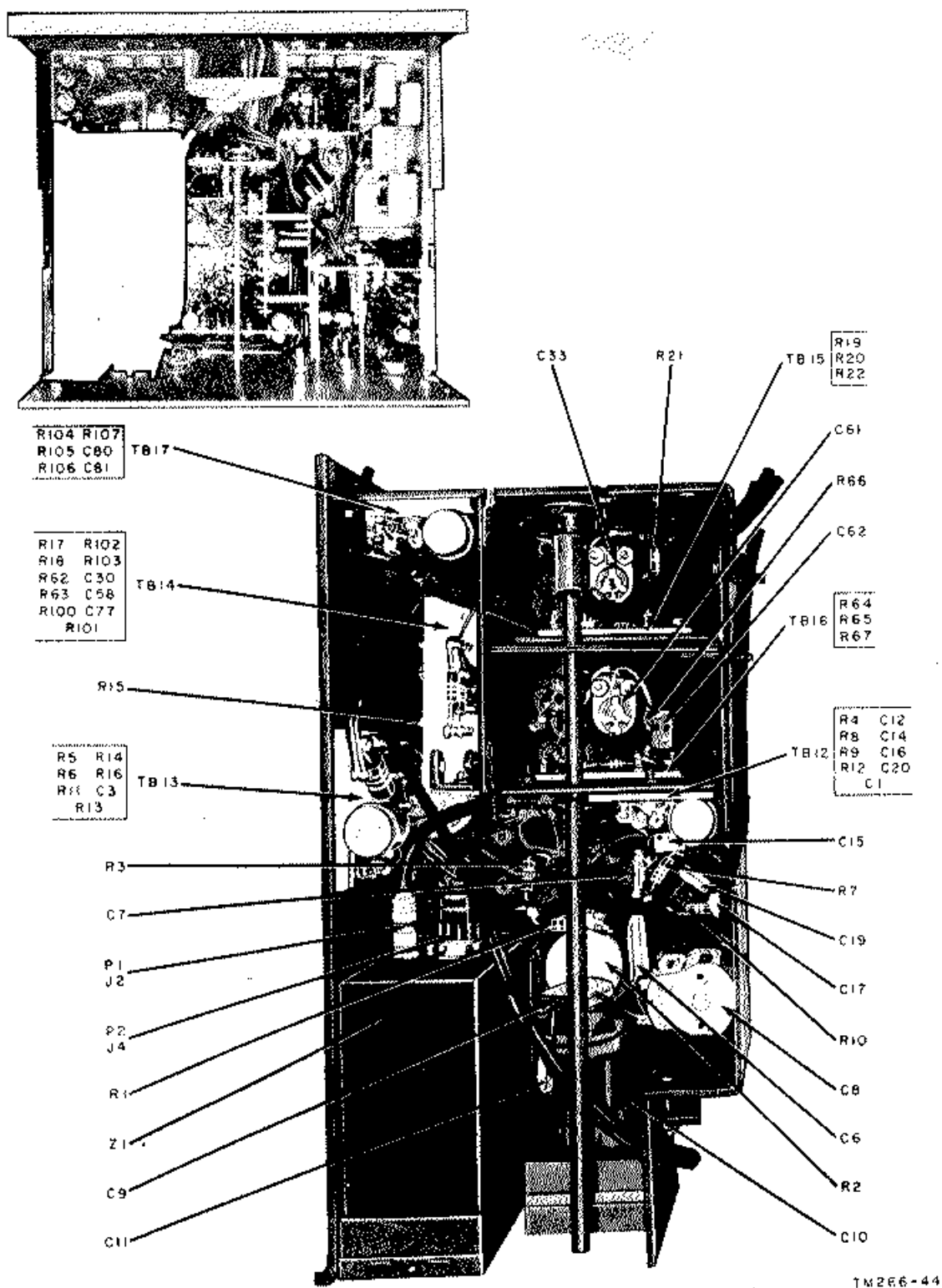
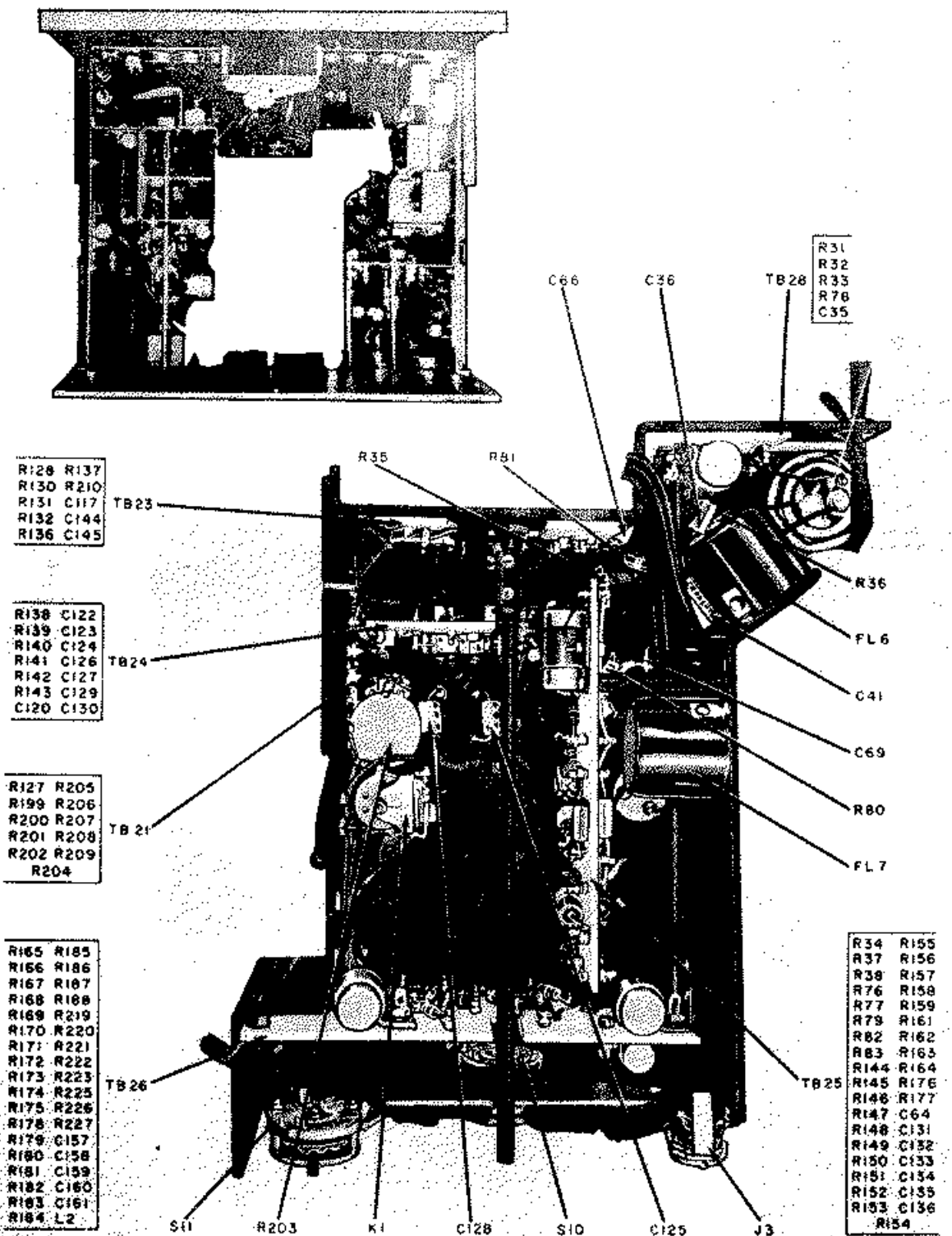


Figure 34. Converter drawer assembly, bottom view (right section).



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Figure 35. Converter drawer assembly, bottom view (center section).

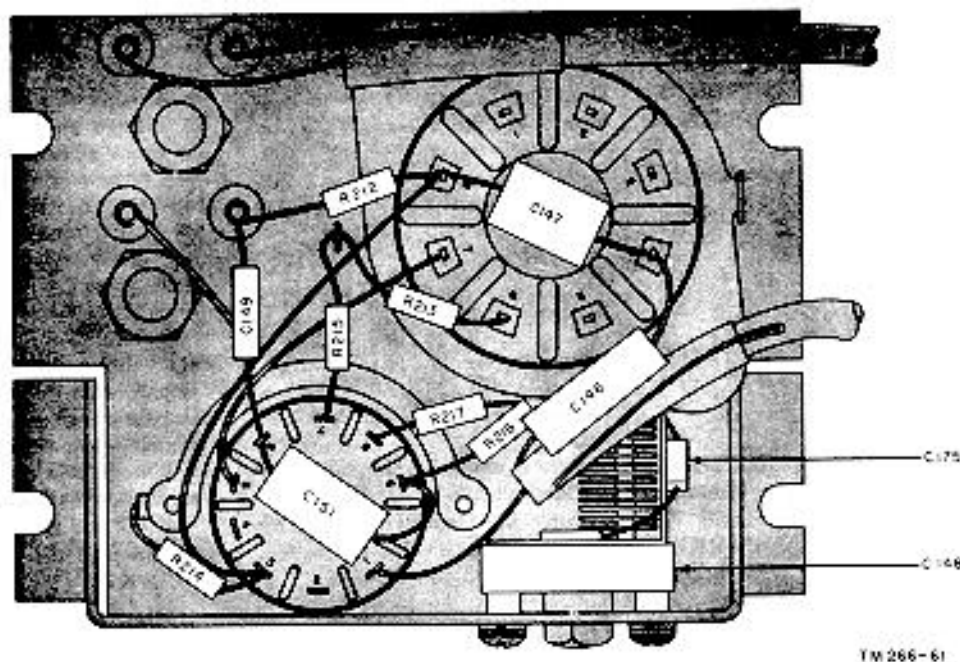


Figure 36. Oscillator section, bottom view.

sufficient to isolate the defective part. However, sometimes it may be necessary to run the signal tracing check (par. 43). Normal voltage and resistance measurements are given in figures 64 and 65. Instructions for

connecting the converter for use with this chart are given in paragraph 40. Signal substitution and tracing procedures are described in paragraph 44.

Item	Symptom	Probable trouble	Correction
1	CB1, converter power switch throws automatically to OFF position.	Short circuit in converter.....	Disconnect converter from power source. Check B+, B- and filament supplies for shorts (par. 39). Check between terminals of P3 for a short. Trace short circuit following voltage and resistance data charts (fig. 64 and 65).
2	Pilot lamp I 3 fails to light when CB1 is in ON position.	I 3 burned out. VOLTAGE SELECT switch S12 (fig. 5) in wrong position and/or TB3 TB4 tapped improperly. Failure in T17 (fig. 30).....	Check I 3. Replace. Check S12 and power transformer T17 primary taps (on TB3 and TB4).
3	No audio output at MONITOR jack J3 when VU METER indicates audio signal present.	MONITOR GAIN and MONITOR switches improperly positioned. Failure in monitor circuits.....	Check T17, voltages and resistance. Check setting of these controls.  Signal trace audio through S3 and through monitor amplifiers V9 and V10 by using headset isolated by .1-microfarad (uf) capacitor. Check S3 (fig. 37). Use tube socket voltage and resistance chart to check circuits of V9 and V10 (figs. 64 and 65).

## 41. Troubleshooting Chart-Continued

Item	Symptom	Probable trouble	Correction
4	No indication on VU METER, no audible signal at MONITOR jack for either channel A or B, but CARRIER LEVEL meter indicates.	Converter improperly tuned..... Failure in V9.....  Failure in local carrier oscillator V35  Failure in S6.....  Failure in S1.....	Retune converter. Use voltage and resistance charts to check circuits of V9 and V10 (fig. 64 and 65). Replace.  Throw CARRIER SELECT switch S6 to RC position. If monitoring facilities indicate signal is now present, use voltage and resistance charts to check circuits of V35. Replace. Make continuity check of S6. Repair when possible. Replace. Make continuity check of S1. Repair when possible. Replace.
5	Sideband tone monitors satisfactorily in appropriate channels on either RC or LC position of CARRIER SELECT switch S6. CARRIER LEVEL meter does not indicate. SQUELCH ALARM lamp lights and remains lighted as soon as SQUELCH switch is turned to the ON position.	Failure in squelch voltage rectifier V32. Failure in CARRIER LEVEL meter M2 or its circuits.	Use voltage and resistance charts to check circuit of V32. Replace. Check M2 and its circuits. Repair or replace.
6	No indication on VU METER when signals are audible at MONITOR jack.	VU RANGE or VU SELECT switch improperly positioned. Failure in VU METER amplifying circuit.	Check setting of these controls. Use voltage and resistance charts to check circuit of V9 (fig. 64). Check S4 and S5 (fig. 37).
7	No indication on VU METER. No audible signal at MONITOR jack <i>in one channel</i> (either A or B), but when SB SELECT switch is turned to interchange channels (VU SELECT and MONITOR switches also appropriately changed), VU METER deflects and signal becomes audible in new channel. CARRIER LEVEL meter indicating satisfactorily.	If channel A fails but channel B operates properly, failure is in channel A between S1 and T5 (fig. 67). If channel B does not operate but channel A operates properly, failure is in channel B between S1 and T6 (fig. 67).	Use voltage and resistance charts to check V5, V6, V7, and V8. Run continuity checks on FL2, FL6, and S2B. Replace if necessary. Use voltage and resistance charts to check V12, V13, V14, and V15. Run continuity checks on FL4, FL7, and S2A. Replace if necessary.
8	<i>Lower</i> sideband frequencies do not monitor or give VU METER indication in either channel A or B. <i>Upper</i> sideband frequencies audible when monitored in either channel and give satisfactory indications on VU METER in both channels. CARRIER LEVEL meter indicates satisfactorily.  <i>Upper</i> sideband frequencies do not monitor or give VU METER indication in either channel A or B. <i>Lower</i> sideband frequencies audible when monitored in either channel and give satisfactory indication on VU METER in both channels. CARRIER LEVEL meter indicates satisfactorily.	Failure in circuit of V4.....    Failure in circuit of V11.....  Failure in S1.....	Use voltage and resistance data charts and check V4. Trace signal through these elements. Also check continuity of T3, FL1, and T4.    Use voltage and resistance charts and check V11. Also check continuity of T6, FL3, and T7.  Make continuity check of S1.

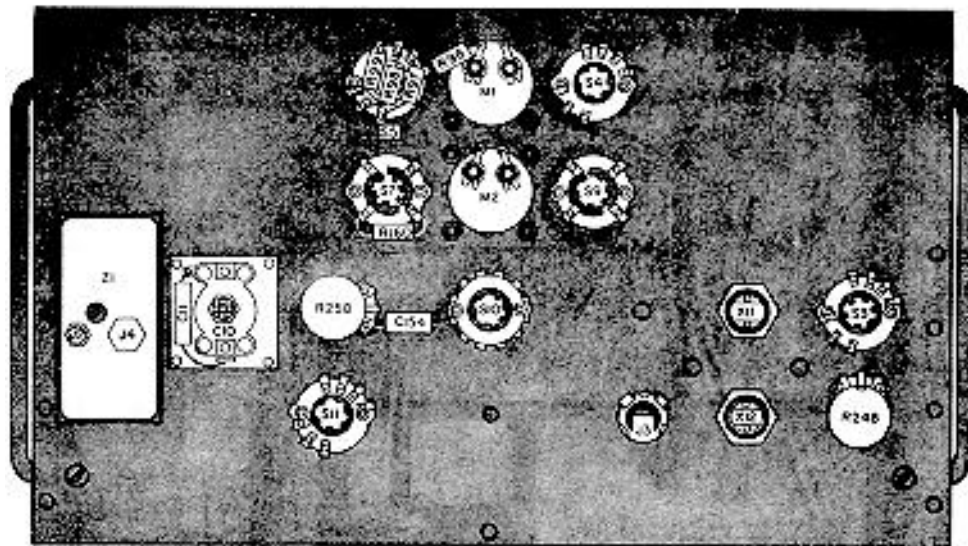
## 41. Troubleshooting Chart-Continued

Item	Symptom	Probable trouble	Correction
9	Sideband intelligence may be monitored in LC position of CARRIER SELECT switch, but not in RC position. AFC INDICATOR does not move when AFC switch is in ON position. CARRIER LEVEL meter indicates satisfactorily and SQUELCH ALARM does not light when SQUELCH switch is in ON position.	Failure in circuit of V19, V20, or V21.	Use voltage and resistance charts to check circuits of limiter strip. Check tubes V19, V20, and V21.
10	Sideband intelligence may be monitored in LC position of CARRIER SELECT switch, but not in RC position. AFC INDICATOR shows satisfactory tracking of afc circuit. CARRIER LEVEL meter indicates satisfactorily. SQUELCH ALARM does not light when SQUELCH switch is in ON position.	Failure in CARRIER SELECT switch, S6.	Make continuity check of S6. Repair or replace.
11	Sideband intelligence may be monitored in LC position of CARRIER SELECT switch, but not in RC position of CARRIER SELECT switch. CARRIER LEVEL meter shows no reading. SQUELCH ALARM lamp lights immediately when SQUELCH switch is turned to ON. AFC INDICATOR shows no tracking of afc circuit.	Failure in circuit of V16, V17, or V18.	Use voltage and resistance data charts to check circuits of V16, V17, and V18.
12	No intelligence in either channel indicated by monitoring facilities in both LC and RC positions of CARRIER SELECT switch. No reading on CARRIER LEVEL meter. SQUELCH ALARM lights and remains lighted when SQUELCH switch is turned ON.	Failure in mixer, heterodyne oscillator, or first if amplifier.	Use voltage and resistance data charts to check circuits of V1, V2, and V3.
13	SQUELCH ALARM lights and stays lighted after SQUELCH switch is turned ON, even though CARRIER LEVEL meter indicates satisfactory input to limiter strip. AFC INDICATOR does not track frequency drifts	Squelch adjustments poorly made..... Failure in relay K1..... Failure in V33 or V34.....	Check squelch circuit (par. 76). Check K1 (par. 47). Use voltage and resistance data charts to check circuits of V33 and V34.
14	SQUELCH ALARM does not light, even when signal generator is disconnected from converter IF. INPUT receptacle.	Failure in circuit of V19, V20, or V21. Failure in I 1..... Squelch adjustments poorly made..... Failure in V32, V33, or V34..... Failure in relay K1..... Failure in S9.....	Use voltage and resistance data charts to check circuits of V19, V20, and V21. Check I 1. Check adjustments in squelch circuit (par. 64). Use voltage and resistance data charts to check circuits of V32, V33, and V34. Check K1. Make continuity check of S9.

## 41. Troubleshooting Chart-Continued

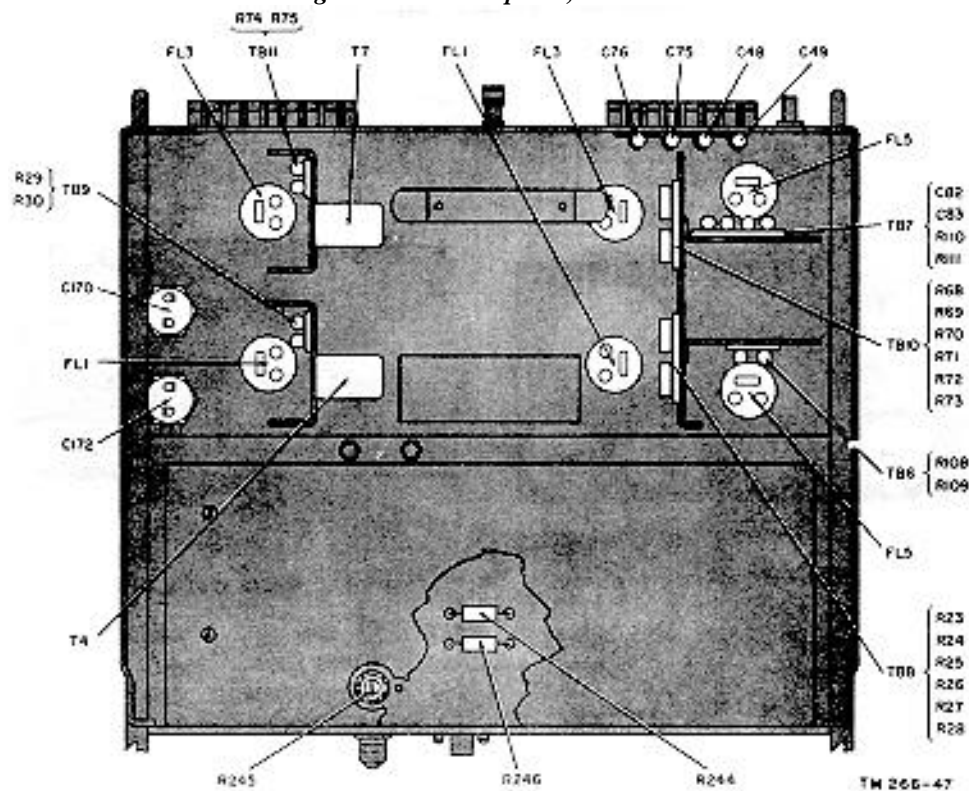
Item	Symptom	Probable trouble	Correction
15	AFC INDICATOR does not move when converter VERNIER control is moved <i>slowly</i> . SQUELCH ALARM lamp lights, when VERNIER control has been moved slightly. Monitored intelligence changes in pitch (in LC position of CARRIER SELECT switch) as VERNIER control is moved.	P2, J4 (fig. 37) disconnected..... Failure in afc gate.....  Failure in tripler V35B.....  Failure in afc circuit.....	Check P2 and J4. Use voltage and resistance charts to check output circuits of V22. Use voltage and resistance charts to check circuit of V35B. Refer to paragraph 48.
16	AFC INDICATOR shows erratic tracking. Converter continually detuned by afc circuit. SQUELCH switch ON.	Converter or receiver improperly tuned.  Poor signal being received and squelch circuit has failed.	Check tuning instructions for type of operation being used. If possible, check quality of received signal. Check output of receiver to converter. If signal input to converter is present, run squelch circuit alinement procedure (par. 64) as <i>check</i> , (follow procedure, but make no adjustments. This will localize trouble or improperly set threshold adjustment.) Refer to paragraph 48.
17	AFC INDICATOR runs continually when converter input signal has not drifted appreciably.	Failure in afc circuit	Refer to paragraph 48.
18	AFC DRIFT ALARM lamp does not light when AFC INDICATOR reaches +2 KC or -2 KC calibration mark.	Failure in S8 or I 2	Check switch (located in Z1) and lamp.
19	Unsatisfactory audio-output level from converter in either channel A or B (but not both) when A-VC and B-VC controls properly set. CARRIER LEVEL meter registers. AFC operative.	Failure in sideband amplifier, demodulator or audio-output stages of affected channel.	Use voltage and resistance charts to check circuits of V5, V6, V7, and V8 if failure in channel A. Check V12, V13, V14, and V15 if failure in channel B.
20	Overly distorted audio output from converter.	CHAN. A BIAS ADJUST or CHAN. B BIAS ADJUST control improperly adjusted, or other amplifier defects.	Use voltage and resistance checks of amplifiers involved, particularly grid biases (par. 66).
21	No agc voltage applied from converter to receiver (for any position of AGC SELECT switch).	AGC OUTPUT and/or AGC THRESHOLD adjustments improperly made. Failure in S10..... Failure in agc amplifiers or rectifier. ...  Failure in receiver agc system.....	Refer to paragraph 67 for procedure for making these adjustments. Make continuity check of S10. Use voltage and resistance charts to check circuits of V36 and V37. Check receiver agc system by using appropriate manual.
22	When AGC SELECT switch is one of the converter positions, input signal from receiver immediately cuts off.	SB AGC control improperly set..... AGC OUTPUT or AGC THRESHOLD adjustments improperly made. Failure in receiver agc system.....	Check setting of this control. Refer to paragraph 67 for procedure for making these adjustments. Use appropriate manual to troubleshoot receiver agc circuit.
23	VU METER shows reading (which may demonstrate a very-low-frequency beat) with no modulation applied to converter.	Excessive energy getting into audio circuits.  Excessive noise feeding through audio circuits. (probably audible in phones.)	Check adjustment of FL6 and FL7 (par. 55). Trace possible leakage from local carrier circuit. Check performance of audio tubes. Check possible noisy connections at tube pins and components connections.





TM 266-46

Figure 37. Control panel, rear view.



TM 266-47

Figure 38. Converter base assembly, top view.

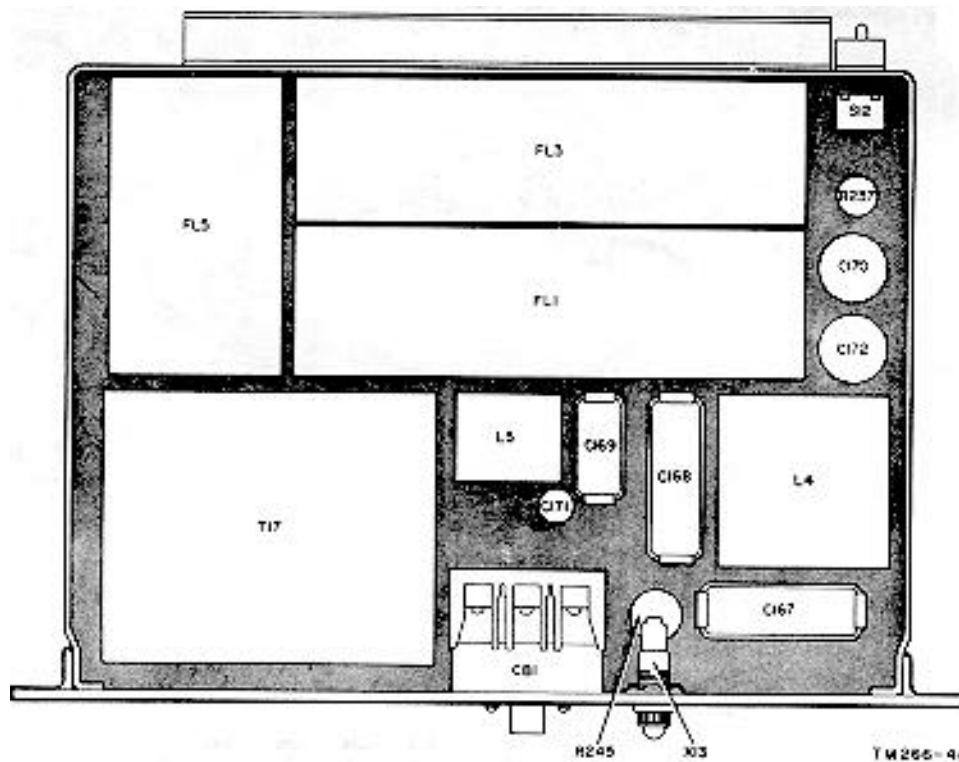


Figure 39. Converter base assembly, bottom view.

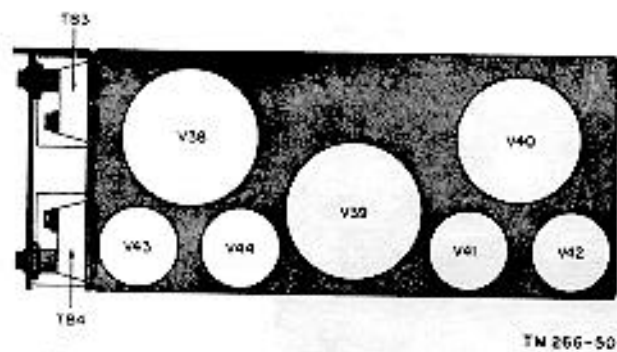


Figure 40. Power supply tube chassis, top view.

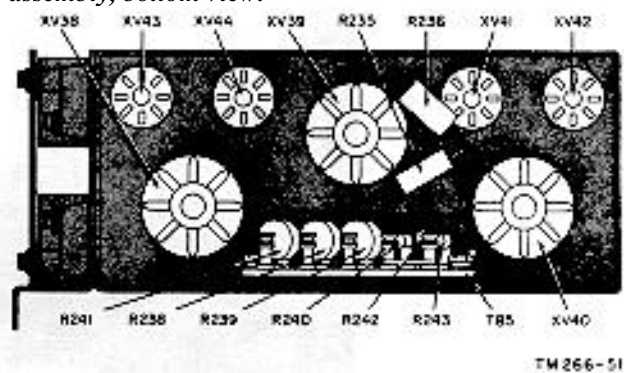


Figure 41. Power supply tube chassis, bottom view.

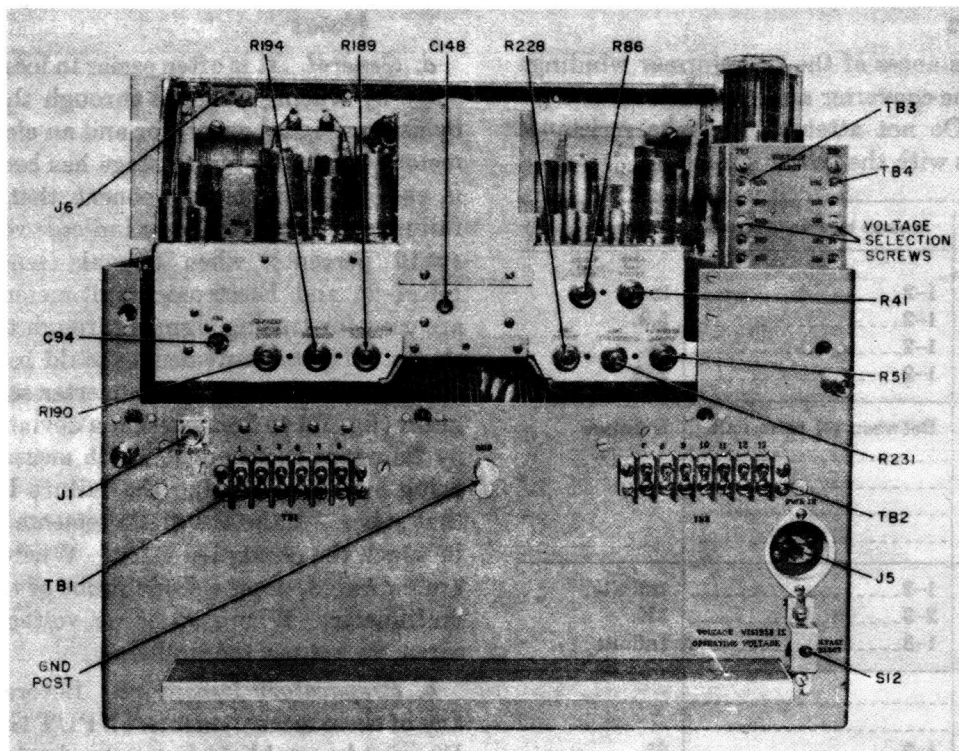


Figure 42. Converter rear view, dust cover removed.

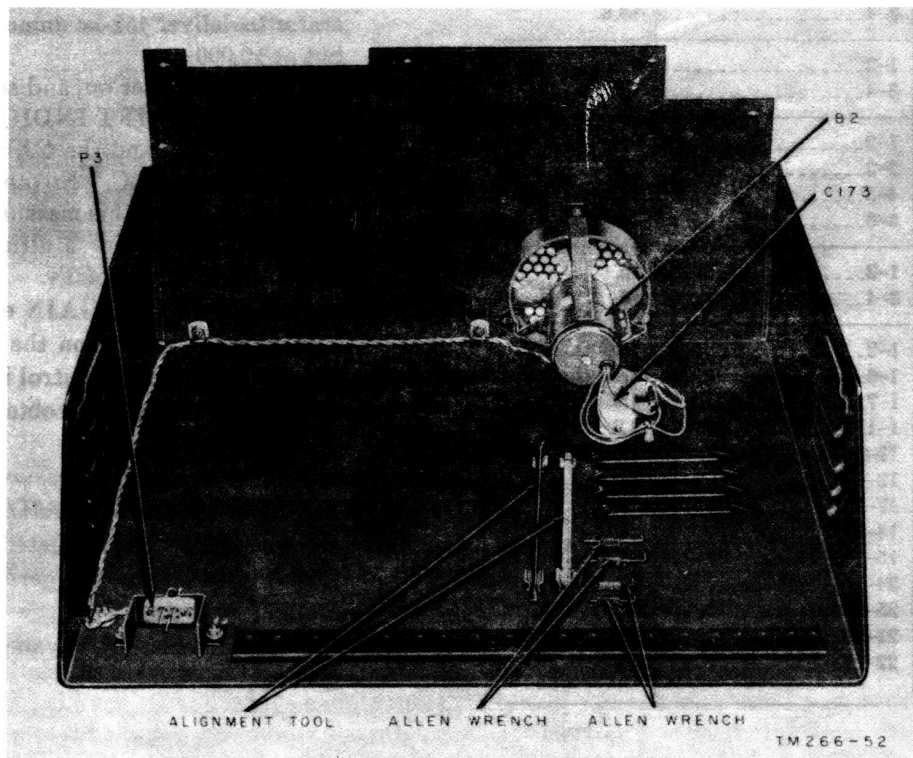


Figure 43. Interior of converter dust cover.

## 42. Dc Resistances of Transformers, Coils and Filters

The dc resistances of the transformer windings and coils in the converter are listed below:

**Caution:** Do not attempt to make resistance measurements with the power turned on.

Transformer or coil	Measure between terminals	Resistance (ohms)
L1 .....	1-2 .....	2.
L2 .....	1-2 .....	5.3.
L4 .....	1-2 .....	55.
L5 .....	1-2 .....	230.
FL1 .....	Between all terminals.	Infinite.
FL3 .....	.....	
FL5 .....	.....	
FL6 .....	.....	
FL7 .....	.....	
FL2 .....	1-2 .....	Infinite.
FL14 .....	2-3 .....	3K.
	1-3 .....	Infinite.
T2 .....	.....	
T9 .....	.....	
T10 .....	1-2 .....	65.
T11 .....	3-4 .....	65.
T12 .....	.....	
T3 .....	1-2 .....	80.
T6 .....	3-4 .....	13.8.
T4 .....	1-2 .....	1.5.
T7 .....	3-4 .....	1.5.
T5 .....	1-2 .....	800.
	2-3 .....	800.
T8 .....	4-5 .....	21.
	5-6 .....	21.
T14 .....	1-2 .....	30.
T16 .....	3-4 .....	16.
T17 .....	1-2 .....	Less than 1.
	1-6 .....	Less than 1.
	1-7 .....	1.6.
	1-11 .....	2.2.
	19-20 .....	Less than 1.
	12-13 .....	0.
	17-18 .....	0.
	14-15 .....	26.
	15-16 .....	26.
	24-25 .....	0.
	25-26 .....	0.
	21-22 .....	70.
	22-23 .....	70.

## 43. Signal Substitution and Signal Tracing Notes

*a. General.* It is often easier to localize a faulty stage by tracing a signal throughout the equipment by using a signal generator and an electronic volt-meter. Once the faulty stage has been located, it is easy to find the component that caused the failure. The charts below indicate voltage values ( $\pm 10$  percent) when Signal Generator AN/URM-25 and Electronic Multimeter ME-6A/U are used for tracing signals through the converter stages. The measurements should be taken while simultaneously using the converter schematic diagram (fig. 67) to find whether a deviation is caused by failure in the stage at which measurements are being made, or whether the failure lies ahead of that stage. Make the measurements in the order in which the charts list them. Where rf voltages are indicated, use the diode probe of the electronic multimeter. Where ac or dc voltages are indicated, do not use the probe.

*b. Preparatory Procedure.* Before attempting any of these measurements, INPUT GAIN control R2 must be established at a standard setting. To establish this standard, proceed as follows:

- (1) Connect Signal Generator AN/URM-25 at IF INPUT jack J1. Set the generator to deliver 452-kc unmodulated output at 10,000 uv.
- (2) Turn the converter on, and set the VERNIER AND DRIFT INDICATOR controls at O, KC, and the CARRIER SELECT switch at LC. No other converter controls influence this measurement.
- (3) Connect Electronic Multimeter ME-6A/U at terminal 3 of T4.
- (4) Adjust the INPUT GAIN control for a reading of .1 volt rf on the multimeter.
- (5) The INPUT GAIN control is now at the standard setting used to obtain the measurements below.

*c. Carrier and Agc Section Measurements.*

- (1) Set Signal Generator AN/URM-25 to deliver 455-kc unmodulated output at 1,000 uv. Connect the generator at IF INPUT jack J1.
- (2) Set the converter front panel controls as follows:

Control	Setting
AFC.....	..ON.
AGC SELECT.....	..CAR.
CARRIER SELECT .....	..RC.
DRIFT INDICATOR.....	..Q. KC.
VERNIER.....	..To center signal in carrier stages as indicated by reading on the CARRIER LEVEL meter.
CARRIER COMPENSATOR.	To produce midscale reading on CARRIER level meter.
SQUELCH.....	..ON.

*Note.* It is impossible to obtain correct tracking of the afc circuit, turn the AFC control to OFF and proceed with the measurements. These symptoms indicate failure in the converter and it is probable that signal tracing procedure will reveal the faulty stage.

- (3) Make all the following measurements to ground with rf or dc probe of Electronic Multimeter ME-6A/U.
- (4) To check the clipping action of the carrier limiter section (V19 (V20, AND V21) and V21), increase the output of the signal generator to 10,000 uv. Reset the CARRIER COMPENSATOR to provide midscale reading on the CARRIER LEVEL meter, and repeat the measurement at terminal 3 of T13. It still should measure 12 volts. To check the amplifying action of the limiter strips turn the SQUELCH control to OFF and reduce the output of the signal generator to 110 uv. Readjust the CARRIER LEVEL COMPENSATOR to restore the midscale reading on the CARRIER LEVEL meter. The rf reading at Terminal 3 of T13 should not be reduced more than 2 db (9.3 volts).

Stage	Voltage	Make measurement at			Reading (volts rf)	Remarks
		Tube	Pin	Other		
Oscillator (V2).....	Output.....	V1	2	.....	8	Remove V2.
Mixer (V1) .....	Input .....	V1	7	.....	.00069	
	Output.....	V3	1	.....	.0165	
First if. amplifier (V3) .....	Output.....	.....	...	Junction of R100, R101, R102.	.026	If measurements to this point are correct but CARRIER LEVEL meter does not indicate properly, failure is in V32 or meter.
Carrier if. amplifier (V16).....	Output.....	.....	...	Junction of C81 and R108.	.61	
Filter (FL5).....	Output.....	.....	...	Junction of R110, R111.	.006	
First carrier amplifier (V17) ....	Output.....	V18	1	.....	37	If measurements to this point are correct and SQUELCH ALARM remains lighted, failure is in squelch circuit.
Second carrier amplifier(V18) ..	Output.....	V19	2	.....	49	
First carrier limiter (V19) .....	Output.....	V20	2	.....	3.0	If all measurements to this point are correct and AFC INDICATOR still will not track, failure is in afc circuits.
Second carrier limiter (V20).....	Output.....	V21	2	.....	9.7	
Third carrier limiter (V21) .....	Output.....	.....	...	Term. 3 of T13	12	Remove V35.
Afc gate (V22) .....	Input .....	V22	1	.....	1.5	
	Output.....	.....	...	Term. 3 of T14	1.8	
Local carrier oscillator.....	.....	.....	...	Term. 3 of T15	6.2	Affected by setting of AGC THRESHOLD and AGC OUTPUT controls.
V35						
Local carrier oscillator.....	Output.....	.....	...	Term. 3 of T16	5.7	Remove V22.
First agc amplifier (V36).....	.....	V36	1	.....	.03	
Second agc amplifier (V37).....	.....	V37	7	.....	1.8	
Agc rectifier (V37).....	.....	V37	1	.....	18	
Agc rectifier output .....	.....	.....	...	Junction of R227, C163, and R228		

*d. Converter Upper Sideband, Channel A, and Agc Measurements*

- (1) Connect the rf output of Signal Generator AN/URM-25 to IF. INPUT receptacle J1. Set the generator to deliver an unmodulated 452-kc output at 10,000 uv. The 452-kc signal will beat to fall in the converter upper sideband and will produce an audio tone at the demodulator.
- (2) Set the converter front panel controls as follows:

Control	Setting
VU SELECT	A.
VU RANGE	0 DB.
A-VC	+10 db reading on VU METER.
AFC	OFF.
SQUELCH	OFF.
VERNIER	0 KC.
DRIFT INDICATOR	0 KC.

Control	Setting
SB SELECT.....	A-LSB, B-USB.
AGC SELECT.....	LSB.
CARRIER SELECT....	LC.
SB AGC.....	7.5.
AGC TIME .....	MIN.

*Note.* If it is impossible to obtain a +10 db reading on the VU METER by adjusting the A-VC control, proceed with the measurements to discover the failure causing this symptom (par. 41).

- (3) Make the following measurements to ground with an rf, ac, or dc probe of Electronic Multimeter ME-6A/U.

Stage	Voltage	Make measurement at			Reading (volts)
		Tube	Pin	Other	
Mixer (V1) .....	Output .....	V3.	1.		.2 rf.
First if amplifier (V3) .....	Output .....			Term...3.of.T2	2.32 rf.
Converter upper sideband if. amplifier.	Input .....	V4.	1.		.245 rf.
	Output .....			Term...3.of.T3	.9 rf.
Converter upper sideband (FL1).....	Output .....			Term...3.of.T4	.1 rf.
Channel A sideband amplifier (V5A).	Output .....	V5.	2.		.1 rf.
Demodulator (v6) carrier .....	Input .....	V6.	8.		4.3 rf.
	Output .....	V6.	1.		1.9 rf.
	Output .....	V7.	2.		.021 ac.
Audio inverter (V7) second triode .....	Input .....	V7.	7.		.019 ac.
	Output .....	V8.	2.		.83 ac.
First triode .....	Output .....	V8.	7.		.94 ac.
Audio output (V8).....				Term...1.of.TB1	1.2 ac.
				Term...3.of.TB1.	1.2 ac.
First agc amplifier (V36).....	Input .....	V36.	1.		.03 rf.
	Output .....	V37.	7.		1.8 rf.
Second agc amplifier (V37) First triode.	Output .....	V37.	1.& 2.		18 rf
Agc rectifier (V37) Second triode.....				Junction.of.R227, C163, and R228.	Affected by setting of AGC THRESHOLD and AGC OUTPUT controls.

*e. Channel B Measurements*

- (1) Set the converter controls to the same positions used in *d* above, with the following exceptions:  
*Note.* If it is impossible to obtain a + 10 db reading on the VU METER by adjusting the B-VC control, proceed with the measurements to discover the source of trouble (par. 41).

Control	Setting
SB SELECT	LSB-B, USB-A.
VU SELECT	B.
B-VC	+10 db reading on VU METER,

- (2) To check the channel B sideband amplifier demodulator, and output stages, connect

the signal generator as in *d(3)* above.

Stage	Voltage	Make measurement at			Reading (volts)
		Tube	Pin	Other	
Converter upper sideband if. amplifier (V4).....	Output....	V12 ....	7	.....	.1 rf.
Channel B sideband amplifier (V12A).....	Output....	V12 ....	2	.....	1 rf.
Demodulator (V13) carrier .....	Input .....	V13 ....	7	.....	4.3 rf.
	Output....	V13 ....	1	.....	1.9 rf.
	Output....	V14 ....	2	.....	.021 ac.
Amplifier-inverter (V14) First Section.....	Input .....	V14 ....	7	.....	.019 ac.
	Output....	V15 ....	2	.....	.83 ac
	Output....	V15 ....	7	.....	.94 ac.
Audio output (V15).....	.....	.....	.....	Term. 4 of TB1 .....	1.2 ac.
				Term. 6 of TB1 .....	1.2 ac.

- (3) Connect Signal Generator AN/URM-25 to IF. INPUT receptacle J1. Set the generator to deliver a 456-kc unmodulated output at 10,000 uv. This 456-kc signal will beat to fall in the converter lower sideband and will produce an audio tone after demodulation

- (4) Set the converter controls as follows:

Control	Setting
VU SELECT .....	B.
VU RANGE.....	+ 10 DB
B-VC.....	0 db reading on VU METER.
AFC.....	OFF.
SQUELCH.....	OFF.

- (5) Make the following measurements to ground with Electronic Multimeter ME-6A/U.
- (6) Restore the original settings of the INPUT GAIN A-VC and B-VC controls at the conclusion of signal tracing test.

Control	Setting
SB SELECT.....	LSB-B, USB-A.
AGC SELECT.....	USB
CARRIER SELECT .....	LC.
VERNIER.....	O KC.
DRIFT INDICATOR.....	O KC

Stage	Voltage	Make measurement at			Reading (volts)
		Tube	Pin	Other	
Mixer (V1).....	Output....	V3	1	.....	.2.
1st if. amplifier (V3).....	Output....	.....	.....	Term. 3 of T2 .....	2.32.
Converter lower sideband if. amplifier (V11) .....	Input .....	V11	1	.....	.245.
	Output....	.....	.....	Term. 3 of T6 .....	.9.
Converter lower sideband filter (FL6).....	Output....	.....	.....	Term. 3 of T7 .....	.1

## CHAPTER 4 REPAIRS

### 44. Removal and Disassembly of Converter for Servicing.

a. Figure 44 shows the steps necessary for removal of the converter from the rack and mechanical disassembly for servicing. Normally, it is not necessary to separate the drawer and base assemblies to reach the bottom of the oscillator section however, release the catches on the drawer slides and separate the base and drawer assemblies.

**Caution:** The cables that connect the drawer and base assemblies are short. Be careful not to break these cables when removing the drawer from the base.

b. The top and the bottom of the oscillator section (containing local carrier oscillator V35 and crystal oven HR1, figure 31) are shielded. Take off the shields by removing the screws that hold them in place.

### 45. Replacement of Parts

a. *General.* Most of the converter components can be easily reached and replaced if found to be faulty. Before attempting the replacement of any part, be sure the power switch is in the OFF position. The premature failure of a replacement part or an associated component can be minimized if the following precautions are observed:

- (1) Be careful when replacing parts that require several electrical connections. As the wires on the part are removed, tag them to facilitate proper connection when the replacement part is installed.
- (2) When leads of other converter components interfere with part replacement, be careful when moving the interfering leads out of the way. The interfering leads, as well as the components, may be damaged.
- (3) Soldering should be done carefully. A carelessly soldered connection may create a

new fault, which will be difficult to find. Free drops of solder left in the equipment are a potential source of trouble.

- (4) A replacement part should be installed in the same position as the original. Give particular attention to proper grounding, when replacing a part. Use the same ground connection as in the original wiring.

b. *Electron Tube Replacement.* Most of the tubes are readily accessible by removing the converter dust cover (fig. 31). Avoid forcing any of the miniature tubes during removal or replacement operations. Careless handling of these tubes may result in bending the base pins. Local carrier oscillator V35 can only be replaced after first removing the oscillator shield located on the rear of the converter chassis. Tubes V38 through V44 are located on the base-mounted power supply chassis (fig. 40). Special precautions should be taken when removing V38, V39, or V40, as they are held in place by base clamps. In addition, V38 and V39 have clamps about the glass envelopes. These clamps must be loosened before the tubes can be removed.

c. *Afc Unit Removal.* Afc unit Z1 must be removed from the converter if the unit is to be disassembled. Remove the DRIFT INDICATOR knob. Disconnect P2 by rotating the locking ring 90° and withdrawing the plug. Disconnect P1 by unscrewing the locking sleeve, thus withdrawing the plug. The afc unit finally may be removed from the converter after the four machine screws that attach the unit to the front panel are removed.

d. *Power Supply chassis Removal.* Several components associated with the power supply circuits are located on the underside of the base mounted power supply chassis must be removed and inverted to reach these components. Remove the six machine screws that hold the chassis to the converter base, and the chassis may be removed from the base assembly.



There is a considerable amount of slack in the cable that connects the power supply chassis and the converter base assembly. The power supply chassis must be inverted carefully to avoid twisting the interconnecting cable excessively.

*e. Carrier Oscillator Section.* To gain access to the bottom of the carrier oscillator section, follow the procedure shown in figure 44.

*Note.* In replacing either the bottom cover or the top shield of the oscillator section, use  $\frac{3}{4}$ -inch (max length) screws to avoid establishing undesired grounds between oscillator subchassis and rf chassis.

*f. Front Panel Removal.* Remove the front panel carefully; panel-mounted components and associated wiring may be damaged. Particularly, the extension shafts which must be re-fitted through the panel on reassembly should be carefully handled to avoid striking components and wiring. Follow the steps below to remove the front panel; the afc unit, indicator lights, and meters remain on the panel.

- (1) Remove all knobs except that of the DRIFT INDICATOR.
- (2) Disconnect PI and P2 from the afc unit (fig. 34).
- (3) Disassemble the nut, dial, and washer from the VERNIER shaft.
- (4) Remove the nuts and washers from MONITOR jack J3 and all other controls.
- (5) Unsolder the leads to indicators I 1 and I 2, and meters M1 and M2.
- (6) Remove the mounting screws that hold the VERNIER capacitor.
- (7) Remove the 10 screws and washers that hold the front panel to the rf chassis.

*g. Access to Components Mounted Beneath Terminal Boards.* To repair or replace some components, terminal boards or other components must be removed. Components that are difficult to reach and the preferred method to reach them are listed in the chart below.

To repair or replace these components	Remove these parts	How
T11 (or any associated with its terminals), C101, C84, and C85 (fig. 32).	Shield (left, fig. 32) .....	Remove two nuts that hold mounting studs. Pull shield straight upward.
Any on the shield side of TB14 (fig. 65).	Adjacent shield (fig. 34) .....	Remove CARRIER COMPENSATOR control shaft by loosening set screw on coupler. Remove two nuts that hold mounting studs. Slide shield straight upward, exposing components.
FL2, TB28, and any associated with sockets for V5, V12, and V6 (fig. 65).	FL6 (fig. 35)..... Coaxial cables .....	Remove two nuts that hold mounting studs; unsolder two leads. Push upward, singly, out of slot in which they lie.
Any associated with socket for V13	SB SELECT switch shaft..... FL (fig. 35).....	Loosen setscrew on coupler. Remove two nuts that hold mounting studs; unsolder two leads.
AGC SELECT switch S10 (fig. 35) CHAN B BIAS ADJUST control R86 (fig. 42). SB AGC control R250.....	SB SELECT switch shaft..... Front panel Cable clamp on chassis adjacent to R86 (fig. 32). Front panel .....	Loosen set screw on coupler. Refer to <i>f</i> above. Remove two mounting screws and nuts.  Refer to <i>f</i> above. Unsoldering leads to front panel components is not necessary since wire slack permits panel to be pulled away from rf chassis enough to allow access to this control.
TB26 or any components on panel side (fig. 65).	Front panel .....	Refer to <i>f</i> above.
	CARRIER SELECT switch shaft (fig. 35). Bracket between front panel and TB26.	Loosen setscrew on coupler. Remove two mounting screws and washers to permit bracket to be moved toward front panel, enough to allow access to components.

To repair or replace these components	Remove these parts	How
FL4 (fig. 31) .....	C74 (fig. 33) .....	Remove mounting hardware only; wire slack permits sufficient movement of capacitor for access to four nuts and washers that secure the filter.
T17 (fig. 39) .....	Panel stiffener.....	Remove six screws that hold L-bracket stiffener to front panel.
	CB1 .....	Disassemble circuit breaker from front panel. Wires need not be unsoldered.
	L5 .....	Remove nuts and washers that hold mounting studs. Move components about ½-inch to leave clearance for removal of T17. Remove four nuts and washers that hold mounting studs on transformer.
L4 (fig. 39) .....	C168 .....	Remove two nuts and washers that hold capacitor to mounting plate, and move component enough to provide clearance for L4. Disassemble L4 from the mounting plate by removing four nuts and washers.

*h. Care in Removal of Components.* Maintenance personnel are advised to use discretion in the removal of components since, in some cases, the disassembly of mechanical mounting will permit access to the desired components, without the necessity of unsoldering leads of adjacent components. When resoldering connections, make sure they are mechanically sound and electrically continuous before the solder is applied.

*i. Fabrication of If. Input Cable (fig. 45).* The if. input cable used with the converter is RG-59/U and its connectors are AN type UG-88/U. Instructions for fabricating a cable for testing or replacement purposes are given in figure 45.

## 46. Disassembly and Reassembly of Afc Unit Z1 (fig 46)

**Caution:** Incorrect alinement of the capacitor drive mechanism (gear train, drive coupling, and capacitor) prevents proper operation of the afc unit and can result in damage to its components. The replacement of capacitor C13 and the disassembly of the gearcase must not, therefore, be undertaken by anyone except qualified personnel.

*a. General.* The afc unit (Z1) is an assembly located in the right front portion of the converter chassis (fig. 31). The essential components mounted inside Z1 are: variable capacitor C13, a gear train and slip clutch for

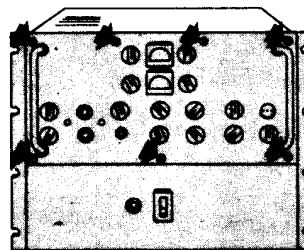
mechanically linking the capacitor to motor B1 and limit switch S8 to activate a warning light when C13 has been driven near minimum or maximum capacity. A coupling and shaft connects C13 directly to the front panel DRIFT INDICATOR knob. The front panel AFC INDICATOR is a spinner disk geared to the motor shaft, and indicates motor rotation when the afc circuit is correcting. The motor leads terminate in J4. The capacitor leads terminate in coaxial connector J2. Both of these receptacles are located on the rear of Z1. Instructions for removing Z1 from the converter are contained in paragraph 45c. An exploded view of the afc unit is shown in figure 46.

*Note.* Do not attempt repair of the afc unit until the failure of the afc system to correct for frequency drift is definitely traced to the afc unit. In some cases, such failure may be localized to something as simple as drag introduced by locating the DRIFT INDICATOR knob too close to the front panel. Clearance between knob and panel should be approximately one-thirty-seconds inch.

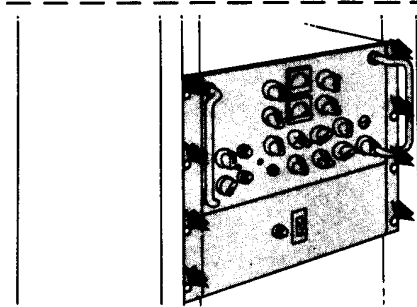
*b. For Access to Microswitch S8, Motor B1, and Connectors J2 and J4.* Using ordinary precautions, the dust cover of Z1 may be removed by electronic maintenance personnel, for partial disassembly of the unit.

- (1) Remove the 1/4-inch 6-32 screw located adjacent to J2 and J4 on the rear of Z1.
- (2) Carefully pull the dust cover straight off. Avoid striking any of the components within.

TO EXTEND THE CONVERTER ON ITS DRAWER SLIDES WITHOUT REMOVING IT FROM THE RACK THESE SEVEN SCREWS-AND NO OTHERS-ARE REMOVED. THE CONVERTER MAY THEN BE EXTENDED BY GRASPING THE HANDLES AND PULLING THE DRAWER ASSEMBLY FIRMLY OUTWARD.



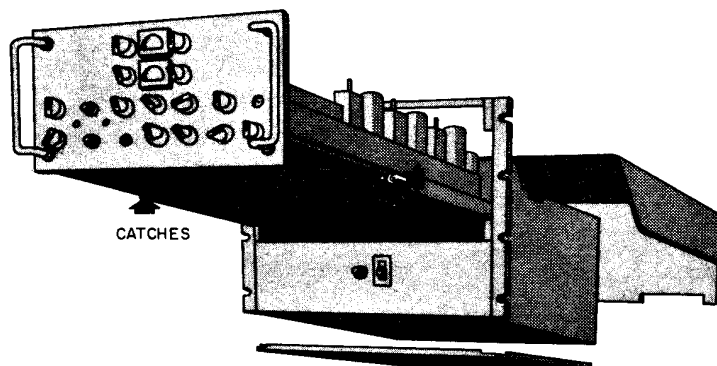
A



THE CONVERTER IS FASTENED IN THE RACK BY THESE EIGHT 12-24 SCREWS,

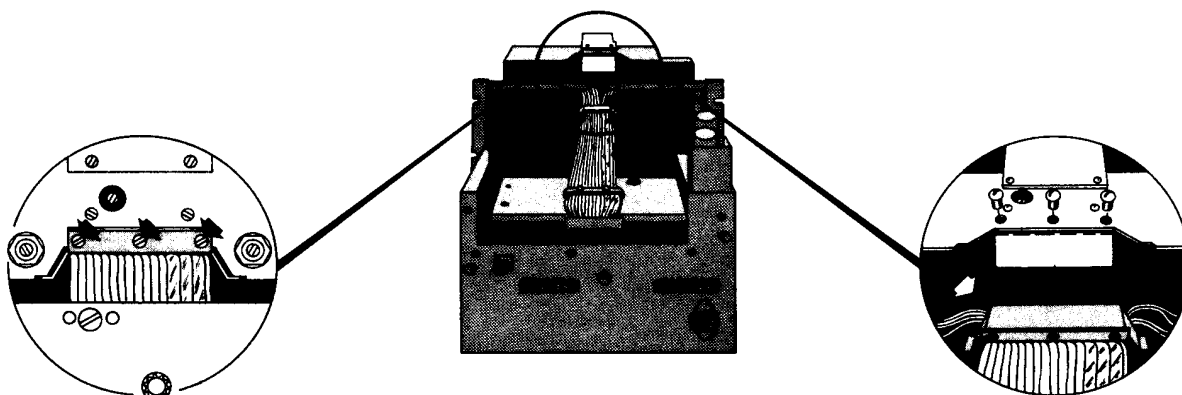
B

THE CONVERTER MAY BE REMOVED FROM THE RACK AND THE DRAWER ASSEMBLY EXTENDED AS SHOWN. MOST NORMAL BENCH SERVICING AND TESTING MAY BE ACCOMPLISHED IN THIS POSITION.



CATCHES

C



TO GAIN ACCESS TO THE BOTTOM OF THE OSCILLATOR SECTION REMOVE THESE THREE SCREWS.

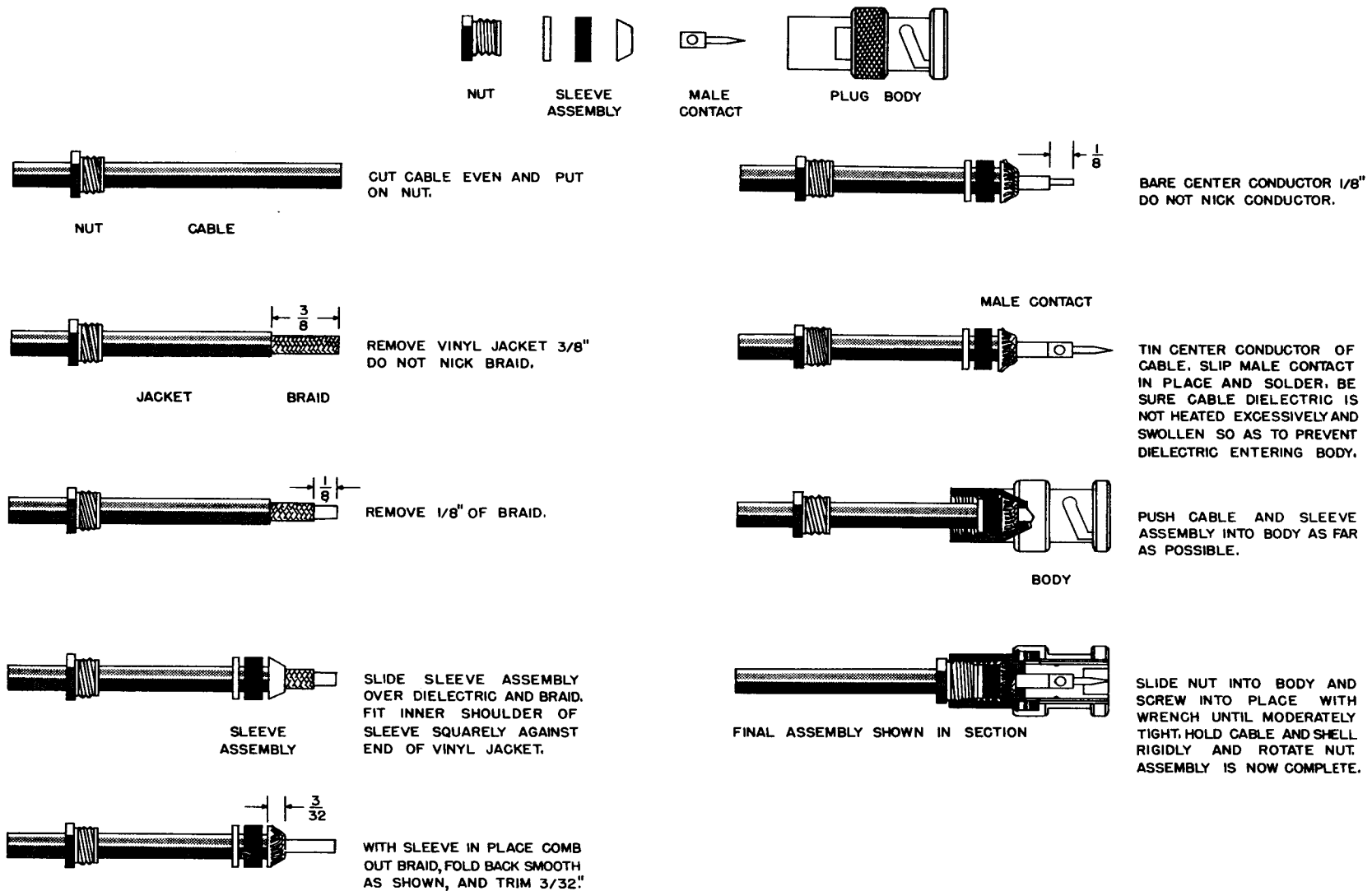
RELEASE THE CATCHES SHOWN IN VIEW "C" THEN UP END THE DRAWER AS SHOWN. THE CABLES WILL FALL AWAY REVEALING THE UNDERSIDE OF THE OSCILLATOR SECTION.

SLIDE THE CABLE CLAMP FREE OF THE CHASSIS.

D

TM266-38

Figure 44. Converter removal and disassembly.



TM 226-62

Figure 45. Method for attaching connectors to RG-59/U coaxial cable.

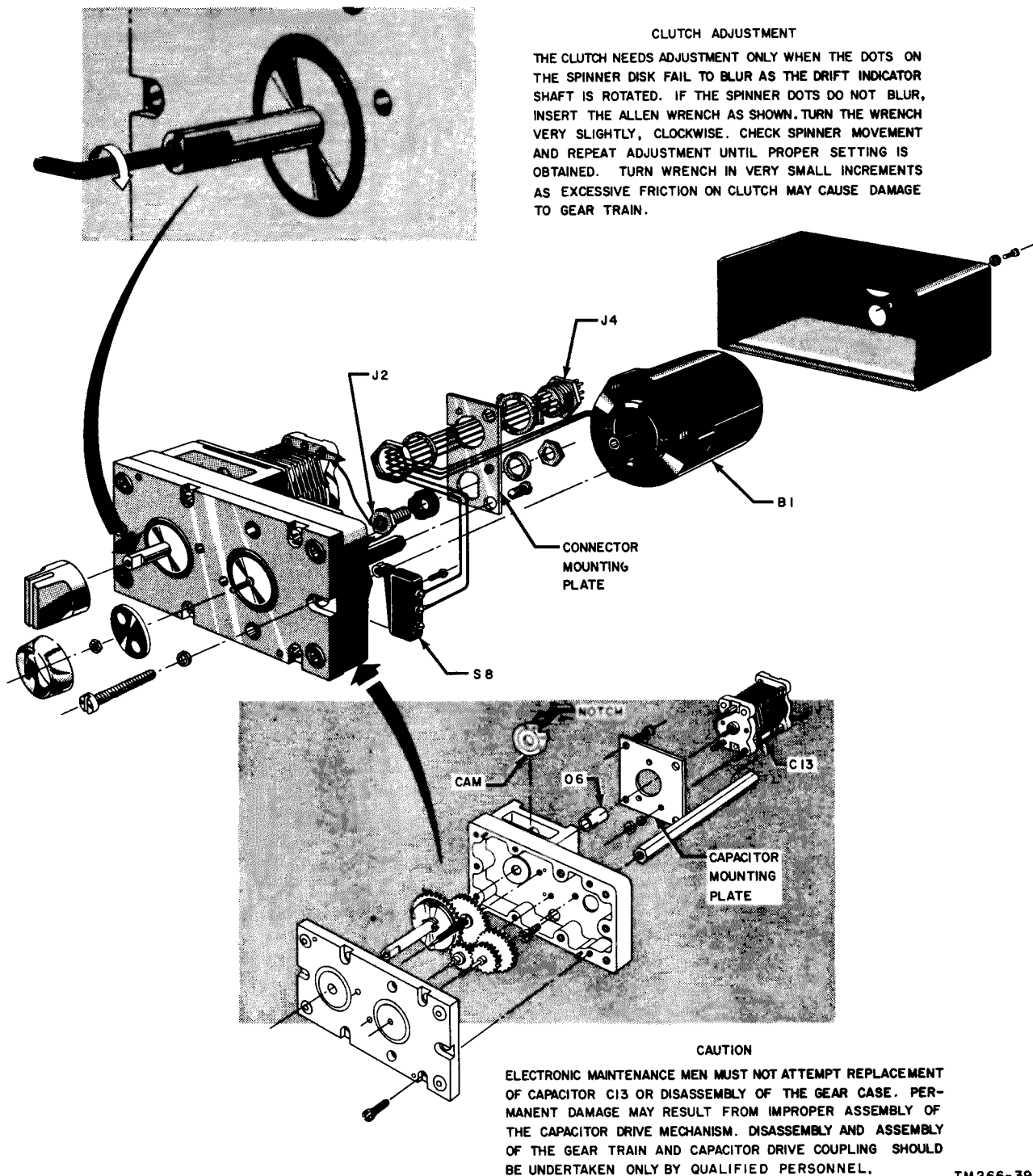


Figure 46. Afc unit, exploded view.

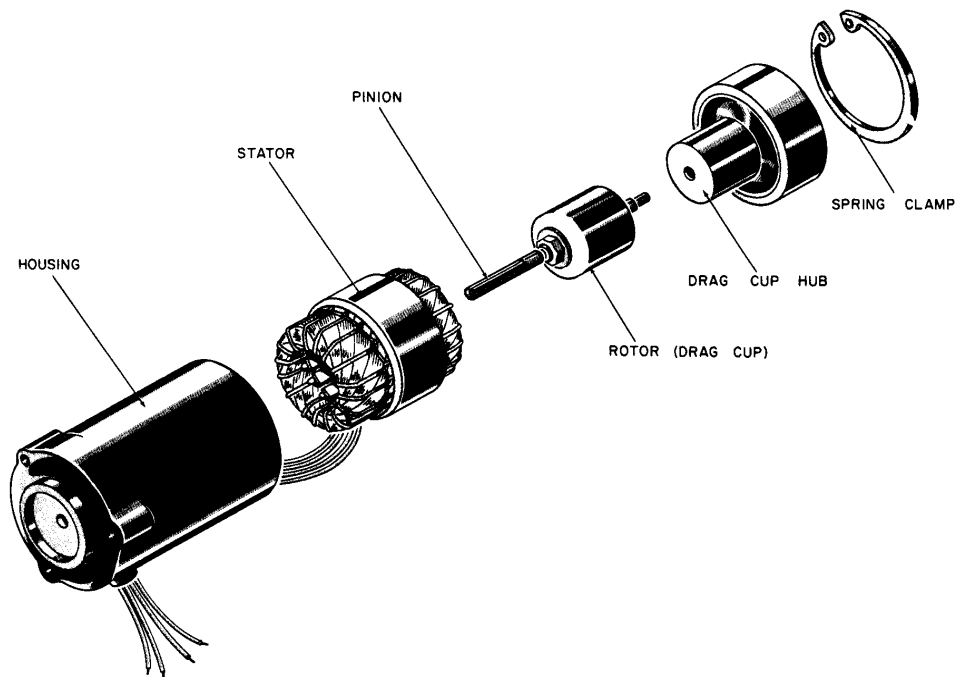
- (3) Inspect the components which are visible for possible mechanical malfunctioning, and for dirty or broken connector leads or loose connector contacts, electrical discontinuity caused by broken leads or loose connections, and dirty or corroded friction contact on the capacitor rotor.
- (4) When it becomes necessary to replace either connector or microswitch, the connector mounting plate must be disassembled from its mounting studs.
- (5) Take out the two 1/4-inch 6-32 counter sunk screws that retain the connector plate. Hold the hexagonal stud with a wrench while removing the associated screw.

**Caution:** Do not remove the two studs on which this plate is mounted. The screws that hold the studs will release into the gearcase, necessitating further disassembly for their recovery.

- (6) The mounting plate may be lifted slightly for access to the solder connections on J2 and J4.
- (7) Connectors J2 and J4 may be replaced by loosening the respective nuts and lockwashers and by unsoldering the leads on the connector concerned.

*Note.* Errors in rewiring the replacement connector can be avoided by tagging each lead as it is unsoldered.

- (8) Disassembly of the motor requires the removal of the three deeply recessed screws on the panel of Z1. These three 1-inch 6-32 screws are identified by their alinement with the mounting bosses on the motor.
- (9) Microswitch S8 can be removed for inspection or replacement by taking out the 7/16 inch 4-40 screws that hold the microswitch and roller bracket to the gearcase, and unsoldering the two leads.
- (10) The size of the mounting holes in S8 will permit some variation in its mounted



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Figure 47. Afc drive motor B1, exploded view.

position. When replacing the switch, the desired position for restoring correct operation of the DRIFT ALARM must be re-established. Locate the switch so that the contacts close (click) as the drive shaft is rotated through positions approximately 73° on either side of the zero drift position (capacitor plates half meshed). The roller bracket may be bent slightly to meet this requirement.

*c. For Removal and Replacement of Capacitor C13.*

**Caution:** This replacement should be undertaken only by experienced instrument technicians equipped to reline the capacitor drive mechanism accurately. Misalignment can result in damage to the afc unit or its continued failure to operate.

- (1) Remove the dust cover of Z1 and disassemble the connector mounting plate as described in b above. Wire slack will allow the plate to be laid back so that C13 can be lifted clear.
- (2) Unsolder the yellow leads connected to the stator and rotor of C13.
- (3) Release the four 1/4-inch 4-40 screws that hold the capacitor mounting plate to the gearcase casting.
- (4) The capacitor and its associated mounting plate may be lifted clear of the gearcase casting. A slight amount of force is required to withdraw the capacitor and capacitor mounting assembly. The assembly will seem to bind because of the force fit of coupling 0.6.

*Note.* Shims may have been added between the capacitor mounting plate and the casting for correct alignment. Retain these shims and use as required to obtain optimum alignment upon reassembly of the capacitor.

- (5) When installing a capacitor, position the drive shaft with the flat in a plane parallel to the straight edge of the capacitor rotor plates (similarly, the curved edge of the rotor is in the same relative position as the rounded section of the shaft).
- (6) The afc unit will not follow the system frequency drift and appropriately correct unless the torque is maintained as listed below: motor B1 engaged at 1.50 inch-pound maximum and motor B1 disengaged at 0.8 inch-pound maximum. When making the

torque measurement, do not allow roller on S8 to ride on the cam. To establish the stated torque, it may be necessary to introduce the shims between the capacitor mounting plate and the casting. Refer to the note in (4) above.

**Caution:** Do not attempt to achieve the desired torque by adjusting the capacitor bearing nut, such adjustment can seriously modify the electrical characteristics of the capacitor.

*d. For Access to Gear Train and Clutch*

- (1) Observe the caution in c above.
- (2) Remove the five shallow set 5/16-inch 6-32 screws from the panel end of Z1. Note that the remaining three screws are more deeply recessed in clearance holds, and hold the motor in place. The motor need not be removed when opening the gearcase.
- (3) The gearcase cover must be in a horizontal plane and must be removed vertically upward. The cover is held in alignment by two pins that offer substantial friction as the cover is removed. If it is necessary to pry the cover off, an even pressure should be exerted to avoid bending the dowel pins and gear shafts. The spinner drive gear remains mounted to the gear housing cover. Avoid damaging the intermediate gear which will be displaced by the spinner gear as the housing cover is lifted.
- (4) Gently pry off the clear plastic cap protecting the indicating spinner. The spinner and its driving gear may be disassembled from the housing cover by unscrewing the nut and spinner.
- (5) Maintaining the gearcase casting in the horizontal plane of (3) above, loosen the two Allen-head screws on the switch activating cam and withdraw the clutch and gear assembly. The unit is reassembled in the reverse order, carefully restoring the original relationship of cam to capacitor plates and observing the precautions listed below:
  - (a) When replacing motor B1, displace it as far away from the capacitors mounting plate as possible, while tightening down its mounting screws. This will prevent the motor pinion gear from

binding due to being *too close* to its mating spur gear.

(b) A very small amount of watch oil (about the quantity that will be picked up by the end of a piece of No. 20 wire) should be placed in each of the gear shaft bearing holes on reassembly. *This is not a preventive maintenance operation.* It should be performed only when reassembling the gearcase after necessary servicing caused by failure of the unit.

(c) When replacing the clutch and gear assembly, proceed as follows:

1. Slip the cam on the drive shaft, noticing the V-notch in the cam and the scribed line on the drive shaft.
2. Assemble the drive shaft to the capacitor coupling, aligning the capacitor rotor plates as described in c(5) above.
3. Locate the center of the V-notch on the cam to coincide with the scribed line on the drive shaft. (After assembly of the coupling to the drive shaft, only a short portion of the line will be visible through the V-notch.)
4. Tighten the cam set screws.

*Note.* A clearance of .005 to .010 inch should be maintained between the cam and the bearing insert on the castings to avoid binding.

5. Re-establish the torque according to c (6) above.

e. *Adjusting Afc Unit Clutch.* After reassembly, the afc unit clutch is adjusted (fig. 46) in the following manner:

- (1) Place the Allen-head wrench in the access hole.
- (2) Turn the knob shaft while observing the spinner disk. *Do not move the wrench while turning the shaft.*
- (3) If the spinner can be made to rotate fast enough to make the dots appear slightly blurred, *do not adjust the clutch.*
- (4) *If the spinner does not move* as noted, turn the wrench *very slightly* in a clock-wise direction. Never turn the wrench counterclockwise.
- (5) Turn the knob shaft once more, observing the spinner disk. If the dots blur, stop the adjustment. Repeat the procedure outlined in (4)

above until the dots blur. Avoid excessive tightening.

- (6) Remove the Allen wrench.

## 47. Relay Adjustments

a. *General.* Relay K1 is located on the underside of the converter chassis (fig. 35). The coil of K1 is connected in the plate circuit of afc gate V22. When the afc circuit is disabled, the current through K1 is reduced, the relay armature is released, and the contacts of K1 complete the circuit between the filament supply voltage and SQUELCH ALARM light I 1. Reliable operation of the converter squelch alarm circuit is dependent on proper operation of K1.

b. *Cleaning.* The greatest source of relay failure is either contact or armature trouble. Contact trouble may be caused by either contact pitting, or by foreign matter lodging between the contacts. Armature trouble may be caused by dirt between the armature and the pole face. Periodic cleaning of the relay will remove these troubles.

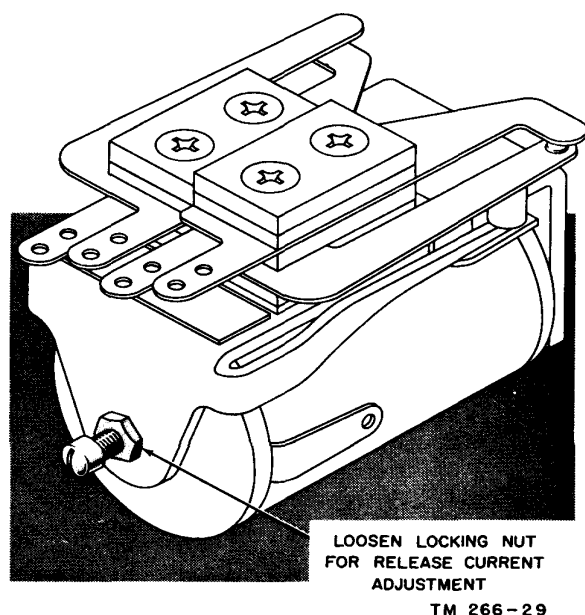
- (1) Use a contact burnishing tool to clean the contacts monthly serves the double purpose of both cleaning and smoothing the contacts. By operating the relay armature manually, the blade of the burnishing tool may be inserted between the contacts.
- (2) Dirt may be removed from between the relay armature and pole face by using a lightweight, lint-free cloth. Use a narrow strip of cloth moistened with a few drops of carbon tetrachloride, and draw the cloth between the armature and pole face.

c. *Testing.* The relay must be adjusted mechanically if it fails to pull-in at a current of 4.5 to 5 milliamperes and release at a current of 3.2 to 3.8 milliamperes. To determine the electrical characteristics of K1, remove one of the leads to the coil of the relay and insert the milliammeter of Multimeter TS-352B/U between the coil of the relay and the disconnected lead. Attach Signal Generator AN/URM-25 adjusted for 1,000-uv output at 455 kc to converter IF. INPUT jack J1. With the SQUELCH switch in the ON position, and the AFC switch in the OFF position, tune in the signal by means of the VERNIER control. Correct tuning is indicated by maximum indication on the CARRIER LEVEL meter. Adjust the SQUELCH THRESHOLD to the point at



which the SQUELCH ALARM lights, indicating release of K1. Note the current through the relay as indicated on the milliammeter. Readjust the SQUELCH THRESHOLD control to cause the relay to pull-in, thus extinguishing the SQUELCH ALARM light. Note the current. Upon completion of this test, restore the original operating setting of the SQUELCH THRESHOLD control (par. 64).

*d. Adjustment.* The release current of the relay may be changed by adjusting the gap between the armature and the pole face. This gap is set with the adjusting screw shown in figure 48. The adjusting screw may be



**Figure 48. Adjustment of relay K1.**

turned after loosening the locking nut. To make the relay release at a lower value of current, turn the adjusting screw clockwise. Turning the screw counterclockwise increases the current at which the relay will release. The adjustment may be made without removing the relay from the converter.

## 48. Troubleshooting Afc Circuit

(figs. 49 and 50)

*a.* The afc circuit in this equipment is not of the extremely critical kind where difficulties caused by component maladjustments will crop up. In most cases, trouble in the afc circuit will be caused by actual

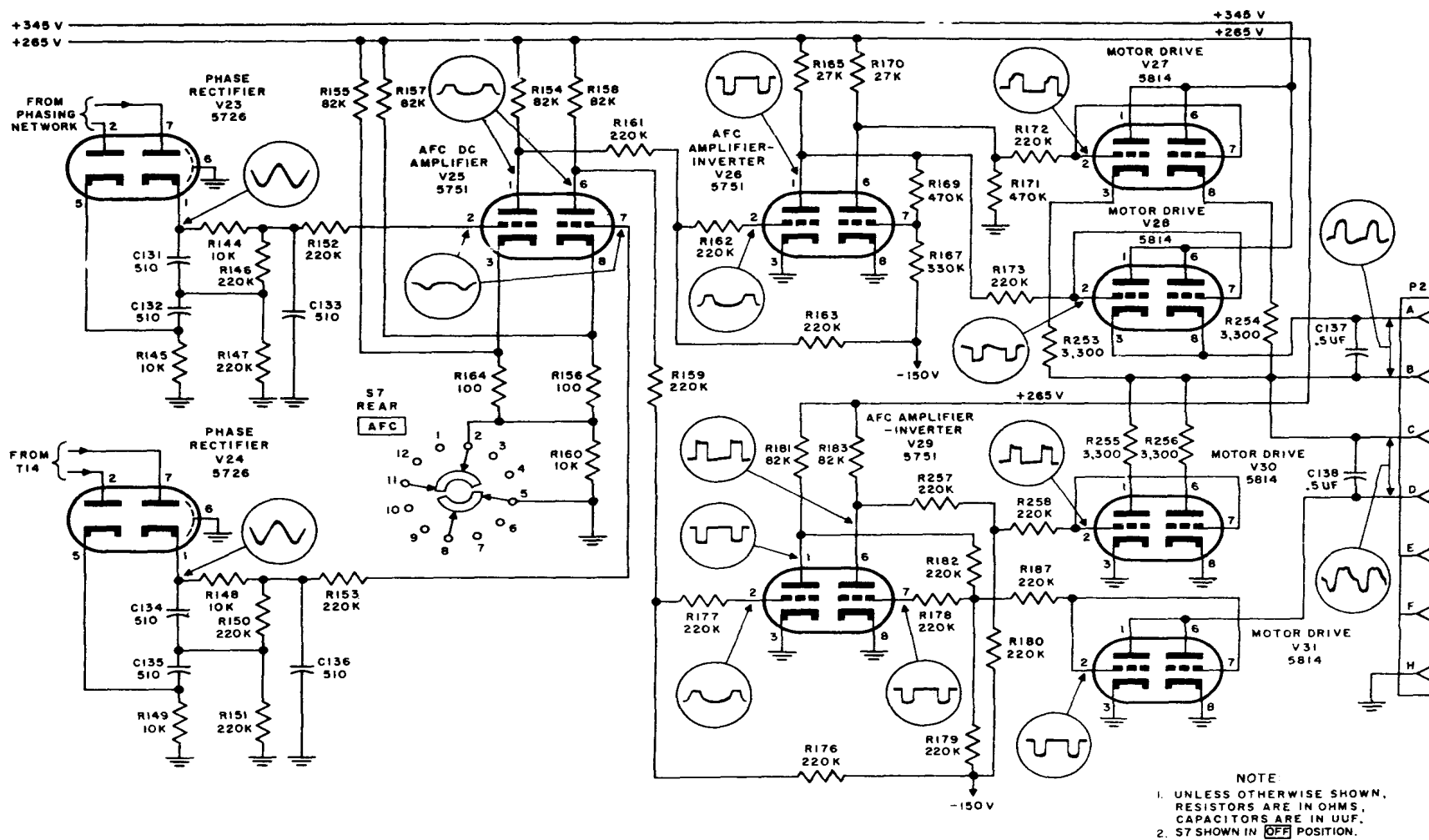
component failures that will be found through use of the troubleshooting chart (par. 41) and ordinary testing procedures. If, for some reason, ordinary voltage and resistance measurements fail to reveal the source of trouble, the signal substitution and oscilloscope checks described below will localize the trouble to a single stage, where the technician will be able to proceed with ordinary tests to isolate the component causing trouble.

*b.* Signal Generator AN/URM-25, Oscilloscope OS-8A/U, Frequency Meter FR-67/U, and a source of 3 volts dc are required for the performance of these tests.

*c.* Prepare the converter for testing by performing the following procedures:

- (1) Disconnect P1 from J2.
- (2) Connect Signal Generator AN/URM-25 at IF. INPUT receptacle J1. Set the generator to deliver 100.000-kc unmodulated output at 1,000 uv.
- (3) Connect Frequency Meter FR-67/U at terminal 3 of T13.
- (4) Set the converter front panel controls as follows: Power to ON; SQUELCH to OFF; CARRIER COMPENSATOR for a midscale reading on the CARRIER LEVEL meter; AFC to OFF. No other controls have any effect on these tests.
- (5) Adjust capacitor C13 (in afc unit Z1) by hand, so that its rotor plates mesh about halfway with those of its stator.
- (6) Adjust the fine tuning of Signal Generator AN/URM-25 for a reading of 100.050 kc on Frequency Meter FR-67/U.
- (7) Disconnect the frequency meter.

*d.* Figure 49 shows the wave forms that should be obtained throughout the afc circuit under the standards established in *c* above. Figures 32, 33, 34, and 35 aid in locating these test points. The Y-axis of the oscilloscope should be connected at the indicated test point and the X-axis to the sweep to obtain the patterns shown. Proceed through the diagram from left to right, tracing the error signal through the afc circuit from its input to its output. When a pattern illustrated in figure 49 is not obtained, test the tubes and run voltage and resistance checks (figs. 64 and 65) in the affected circuit. Allow the motor to run during



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Figure 49. Afc circuit oscilloscope test points.

the tests (if it *does* run). If all the patterns are obtained, and the motor still does not run, the trouble is in the motor. To perform the tests:

- (1) Turn the AFC switch to the ON position.
- (2) Following figure 49, run the oscilloscope tests in the circuit.

*e.* The patterns in tile charts at the left-hand side of figure 49 show phase relationships that should be obtained when the **Y**-axis of the oscilloscope is connected *across* the points indicated when the error signal described above is present.

*f.* Voltages indicated in the chart may be used as a supplementary test to the oscilloscope checks described. In some (and infrequent) instances, correct patterns will be obtained, but they will not be of sufficient amplitude to operate the circuit properly. To test for proper voltages, remove the signal generator from J1 and apply and artificial  $\pm 3$ -volt dc bias to the cathode (pin 1) of either V23 or V24. Application of such a voltage should produce voltages ( $\pm 10$  percent) as indicated in the chart below.

Artificial bias applied at-	Bias	Produce following voltages at-														
Pin 1 of V23		Tube	V25			V26			V27				V28			
		Pins	1	2	1	2	6	7	2	3	7	8	2	3	7	8
3		Voltage	94	0	250	0	150	0	144	175	144	175	225	175	225	175
-3		Voltage	183	-3	150	25	250	-18	228	230	228	230	144	230	144	230
Pin 1 of V24		Tube	V25			V29			V30				V31			
		Pins	6	7	1	2	6	7	1	2	6	7	1	2	6	7
3		Voltage	94	0	190	-25	80	-5	175	-20	-20	175	126	0	126	0
-3		Voltage	183	-3	83	-5	190	-30	119	0	0	119	170	-24	170	-24

*Note.* Conditions for test voltage measurements are as follows: AFC switch is in ON position, P1 is disconnected from J2, voltage measurements are made with 20,000 ohms-per-volt meter, and converter power switch is in ON position. No other control settings affect these measurements.

## 49. Refinishing

Instructions for refinishing badly marred panel or cabinet exteriors are given in TM 9-2851, Painting Instructions for Field Use.

## CHAPTER 5

### ALINEMENT

#### 50. General

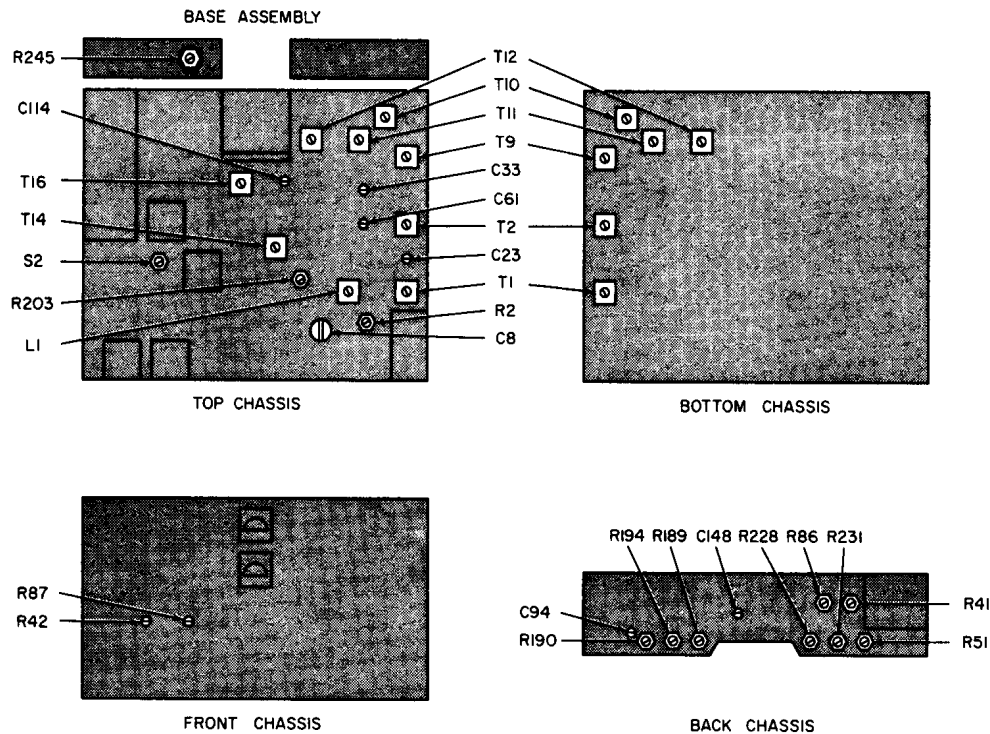
a. *Type of Adjustments.* The alinement adjustments necessary for this converter fall into the following general categories: adjustments made to match the converter to its power source, as well as its associated receiving and terminating equipment, and adjustments demanded by the replacement of a critical component during repair procedures. Both types of adjustment are used to lalin an equipment after it has been reconditioned at a depot or to bring it up to the operating standards. The adjustments most often performed are the former, because these are necessary when the converter is newly installed or when its associated terminal or receiving equipment is exchanged. Alinement and adjustment points are shown in figure 50.

b. *Test Equipment.* The test equipment required to complete the alinement of the converter and the manuals

for this equipment are listed in the chart (par 37).

c. *Tools.*

- (1) A special alinement tool is provided for adjusting the slugs in the variable transformers and coils of the converter. The tool, which is clipped on the underside of the dust cover of the equipment (fig. 43), incorporates a wrench and a socket for adjusting slugs within a single tool.
- (2) A 6-inch screw driver is satisfactory for screw-driver adjustments.
- (3) A 9/16-inch socket or end wrench, or an adjustable end wrench, should be used for loosening the control locking nuts.
- (4) A nonmetallic alinement tool with a screw-driver tip is supplied for the adjustment of capacitors.



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*Fig. 50. Alinement and adjustment points on converter.*

## 51. Alinement Preliminary Procedures

*a. General.* Before the converter is completely realined, the voltage and resistance checks of the B+ and B- supplies (par. 39) should be made.

*b. Control Settings.* Set all converter front panel controls as indicated in the chart below:

Control	Setting
MONITOR (S3).....	OFF.
MONITOR GAIN (R248).....	0.
A-VC (R42).....	Midposition.
B-VC (R87).....	Midposition.
SB SELECT (S1).....	A-LSB, B-USB.
VU SELECT (S4).....	OFF.
VU RANGE (S5).....	+10 DB.
SQUELCH (S9).....	OFF.
AFC (S7).....	OFF.
AGC SELECT (S10).....	REC.
CARRIER SELECT (S6).....	LC.
SB AGC (R250).....	7.5.
AGC TIME (S11).....	FAST
VERNIER (C10).....	0 KC.
CARRIER COMPENSATOR (R112).	6.5.
DRIIFT INDICATOR (C13).....	0 KC.

## 52. Power Supply

*a. Primary Power.* VOLTAGE SELECT switch S12 selects the section of the power transformer primary necessary for converter operation from either a 115- or 230-volt ac power source. Selection of the transformer primary tap to be used is made on terminal board TB3 or TB4 (fig. 42).

- (1) Switch S12 is located immediately below the power receptacle on the rear of the converter case. Loosen the screws that hold the sliding bracket that covers the switch handle.
- (2) If the converter is to be operated from a 105- to 125-volt ac power source, set VOLTAGE SELECT switch S12 to the 115-V position. If the converter is to be operated from a 210- to 250-volt ac power source, set VOLTAGE SELECT switch S12 to the 230 V position.
- (3) Tighten the screws that hold the sliding bracket that covers the switch handle to lock the switch in position.
- (4) Remove the converter dust cover. Terminal boards TB3 and TB4 are located on a single

phenolic board mounted on the rear of the power supply subchassis. This terminal board is accessible from the rear of the converter.

- (5) Determine the line voltage and place the voltage tag screw in appropriate tap position on TB3 or TB4.

*b. B+ Adjustment.*

- (1) Extend the converter drawer assembly and remove the dust cover (fig. 44).
- (2) Place Multimeter TS-352B/U on the 300 volt dc scale. Connect it at the terminal of C172 to which the two red leads are connected. Capacitor C172 is located several inches below the subchassis that contains the power supply tubes (fig. 38).
- (3) Connect the converter to the ac power source with PWR IN jack J5 (on the rear of the converter case). With the converter controls preset (par. 51), throw the front panel switch to the ON position.
- (4) Loosen the locknut on REGULATOR CONTROL R245, which is located near the front of the converter base and which may be reached from the top of the converter when the drawer assembly is extended (fig. 38). This control is adjusted through an access hole in the plate that shields the terminals of components mounted in the converter case.
- (5) After the converter has been on for 10 minutes, adjust R245 for a reading of 265 volts on the multimeter.

## 53. Mixer and First If. Amplifier Alinement

*a. General.* Mixer V1 and first if. amplifier V3 operate into tuned plate loads that are coupling transformers. These transformers have variable, slug-tuned inductances for their primary and secondary windings. The alinement of the two stages consists of peaking these inductances at the converter center if. so that the difference frequency between the input signal from the receiver and the output from the heterodyne oscillator of the converter is selected while unwanted frequencies are rejected.

*b. Preparatory Procedure.*

- (1) Set INPUT GAIN control R2 midway between its extremes of rotation. Set the

converter front panel controls as instructed in paragraph 51.

- (2) Connect a 4,700-ohm, 1/2-watt resistor between terminals 3 and 4 of T1 (fig. 31).
- (3) Connect a 4,700-ohm, 1/2-watt resistor between terminals 1 and 2 of T2 (fig. 31). The purpose of these resistors is to lower the Q in the coils of the transformers and enable them to be individually peaked.
- (4) Connect Signal Generator AN/URM-25 at converter IF. INPUT receptacle J1; use a suitable coaxial cable. The if. input cable assembly provided with the converter is suitable, or a test cable may be made by following the instructions outlined in paragraph 45 (fig. 45). Adjust the signal generator to deliver an unmodulated 100-kc output at a level of about 10,000 uv.

c. *Mixer V1 Alinement.*

- (1) Connect the rf probe of Electronic Multimeter ME-6A/U to the plate (pin 5) of V3.
- (2) Use the special alinement tool to adjust the top (coupling) slug of T1 so that it projects approximately half its length from the top of the transformer.
- (3) Turn on the converter, and allow a 15-minute warming period.
- (4) Adjust the bottom (primary tuning) slug of T1 for a peak reading on the multimeter.
- (5) Remove the resistor from the secondary terminals of T1 and reconnect it between terminals 1 and 2, which are the primary terminals of the transformer.
- (6) Use a nonmetallic alinement tool to adjust C23 (fig. 31) for a peak reading on the multimeter.
- (7) To check the frequency response characteristics of the output circuit of mixer V1, remove the resistor from the terminals of transformer T1. Vary the signal generator between 80 and 120 kc, while simultaneously observing the electronic multimeter. There should be a response peak at approximately 92 kc, a minimum at 100 kc, and a second peak at 107 kc (fig. 55).

- (8) If the peaks are less than 15 kc apart, insufficient coupling at T1 is indicated and the top slug of the transformer should be run in (turned clockwise) until the peaks on either side of the center if. are separated by about 15 kc. This should be determined experimentally. The correct response curve for this transformer is shown in A, figure 55.
- (9) If the peaks are separated by more than 15 kc, T1 is overcoupled, and the top slug of the transformer should be run up (turned counterclockwise) until the peaks are separated by about 15 kc. This is also an experimental operation.
- (10) If it is necessary to readjust the coupling of T1, repeat the procedures in (1) through (9) above.
- (11) When the alinement of this stage is completed, disconnect the signal generator and the multimeter and remove the resistor from T2.

d. *First If. Amplifier V3 Alinement.*

- (1) Connect Signal Generator AN/URM-25, set to deliver a 100-kc unmodulated output at 100,000 uv, at the control grid (pin 1) of V3.
- (2) Connect Electronic Multimeter ME-6A/U, using its diode probe at the control grid (pin 1) of V4. Set the multimeter to measure .3 volt rf.
- (3) Adjust alternately the top and then the bottom slug of T2 for a peak indication on the multimeter.
- (4) Disconnect the signal generator, and the multimeter.

## 54. Sideband If. Amplifier Alinement

a. *General.* The sideband if. amplifying stages ( V4 and V11 ) have plate loads tuned to the center of the pass band of their respective sideband filters. The plate load for each stage is a transformer: T3 in the case of the upper sideband if. amplifier and T6 in the case of the lower sideband if. amplifier. The primary of each transformer is tuned by a trimmer in parallel with the resonating tank. The alinement of the sideband if. amplifying stages consists of peaking the primary

of each transformer at the center frequency of the associated filter, namely, 104 kc and 96 kc.

*Note.* The alinement method to be described actually incorporates the needs both of tuning the sideband if. amplifier stages to the correct frequency and of modifying this tuning to offer slight compensation in the overall audio response characteristic of the equipment. It is essential, therefore, that the audio stages be known to have the desired response characteristic prior to making any attempt to adjust the sideband if. amplifier stages. For this test, it is necessary that the local crystal oscillator be delivering approximately 4 volts to the grid (pin 7) of each of demodulator tubes V6A and V13A. Each audio channel may be checked out by inserting at terminal 3 of T4 a 100,000-uv signal varying in frequency from 100 kc to 106 kc. With the LOWPASS FILTER in the OUT position and the CARRIER SELECT switch in LC position, the SB SELECT switch is placed in A-LSB, B-USB position and the audio level measured across the resistor-loaded output terminals of channel A. The response should be maximum at 101 kc, dropping smoothly .5 db at 103 kc, 1db at 104 kc, and 3db at 106 kc. The SB SELECT switch is then placed in the USB-A, LSB-B position and the check repeated for the alternate channel by measuring the response across the resistance load terminating channel B. Should the response deviate significantly from that outlined, the troubleshooting data (par. 41) should be used.

*b. V4 Alinement.*

- (1) Set the front panel controls as instructed in paragraph 51.
- (2) Connect Signal Generator AN/URM-25 at terminal 3 of T2 (figs. 31 and 10). Set the generator to deliver 100,000 uv at 104 kc, unmodulated.
- (3) Connect Electronic Multimeter ME-6A/U from terminal 3 of TB1 to ground using the diode probe.
- (4) Set the SB SELECT switch to the A-LSB, B-USB position.
- (5) Adjust C33 for maximum reading on the multimeter
- (6) Vary the frequency of the generator from 100.125 kc to 106 kc and observe the variation in level indicated by the multimeter.
- (7) If the overall response varies more than  $\pm 1$  db over the frequency range, readjust C33 to achieve this required audio response. Should the desired response be unobtainable by a simple readjustment of the tuning of C33, troubleshooting in the stage should be undertaken.
- (8) When the desired response of the converter upper sideband if. amplifier is obtained, transfer the multimeter to terminal 4 of TB1 and in the lower sideband if. amplifier.

*c. V11 Alinement.*

- (1) Set the SB SELECT switch to the LSB-B, USB-A position.
- (2) Retune the signal generator to 96 kc and continue to feed 100,000 uv, unmodulated, across terminal 3 of T2.
- (3) Adjust C61 for maximum reading on the multimeter.
- (4) Vary the frequency of the generator from 94 kc to 99.875 kc and observe the variation in level indicated by the multimeter.
- (5) Readjust C61 for an overall audio response that is flat within  $\pm 1$  db over the frequency range of (4) above. Failure to achieve the desired response by adjustment of C61 may indicate the need for troubleshooting in this stage.
- (6) When the desired response is obtained, remove the signal generator and multimeter.

## 55. FL6 and FL7 (100-kc Trap) Adjustment

*a. General.* A high Q resonant trap is provided across each audio volume control and is introduced into the circuit when the LOWPASS FILTER switch is placed in the OUT position. These traps are tuned to 100 kc to bypass any if. energy riding the desired audio signal.

*b. Adjustment.*

- (1) Set the CARRIER SELECT switch in the LC position.
- (2) Place the A-VC control in the maximum clockwise position.
- (3) Connect Multimeter ME-6A/U on grid pin 7 of V7B, using the diode probe.
- (4) Adjust the trimmer capacitor of FL6 for minimum reading on the multimeter.
- (5) Place the B-VC control in the maximum clockwise position.
- (6) Transfer the multimeter to grid pin 7 of V14B.
- (7) Adjust the trimmer capacitor of FL7 for minimum reading on the multimeter.
- (8) The 100-kc traps are now adjusted for maximum absorption of if. energy.

## 56. Carrier Amplifying Alinement

*a. General.* The alinement of first carrier amplifier V17 and second carrier amplifier V18 consists of peaking their output transformers at 100

kc so that the 100-kc signal delivered to the amplifiers from carrier filter FL5 will be amplified as much as possible. The amount of amplification used in operation is controlled by the setting of CARRIER COMPENSATOR control R112.

*b. Tubes V17 and V18 Alinement.*

- (1) Set the converter controls as directed in paragraph 51.
- (2) Set CARRIER METER ADJUST control R190 (fig. 42) at its midposition.
- (3) Connect Signal Generator AN/URM-25 at the control grid (pin 1) of V18. Set the signal generator to deliver an unmodulated output of 100 kc. Adjust the output level so that CARRIER LEVEL meter M2 reads at about quarter scale.
- (4) Alternately adjust the bottom and then the top slugs of T10 to obtain a peak reading on M2. Use the special alinement tool to make this adjustment.
- (5) If, during the course of tuning, M2 reads over half scale, readjust the output level of the signal generator to return the reading to about quarter scale. This operation prevents the amplifier from being over driven, which would result in a spurious indication at M2.
- (6) Disconnect the signal generator from V18 and reconnect it at the control grid (pin 1) of V17.
- (7) Readjust the output level of the generator so that M2 again reads at about quarter scale.
- (8) Adjust alternately the top and then the bottom slugs of T9 for a peak reading on the CARRIER LEVEL meter.
- (9) If, during the course of this adjustment, M2 reads over midscale, readjust the output level of the signal generator to return the reading to quarter scale.
- (10) Disconnect the signal generator from V17.

## 57. Limiter Strip Alinement

*a. General.* The limiter strip consists of three transformer-coupled stages V19, V20, and V21. Alinement of the strip consists of tuning the transformers, either through variable inductors in the transformers or through the use of a trimming capacitor across the

transformer inductance, to resonance at 100 kc. This is the converted carrier frequency.

*b. Preparatory Procedure.* Use the diode probe to connect Electronic Multimeter ME-6A/U at the high-potential end of R133. This resistor is mounted on terminal board TB22 (fig. 32). Determine the correct end of the resistor for the connection of the multimeter by referring to the resistor and capacitor board voltage and resistance data chart (fig. 65). Set up the converter controls as directed in paragraph 51.

*c. V21 Alinement.*

- (1) Connect Signal Generator AN/URM-25 at terminal 3 of T12 (fig. 31). Set the generator to deliver 100 kc unmodulated at an amplitude that will give a satisfactory reading on the lowest rf scale of the multimeter.
- (2) Adjust C114 for a peak indication on the multimeter.

**Caution:** During the alinement of the limiter strip, be careful not to saturate the limiters with the signal introduced from the signal generator. Saturation results in a wide *peak* being obtained, and thus reduces the capabilities of the limiters as amplifiers. During this and all subsequent tuning adjustments a very narrow peak is desirable. Thus, when a maximum indication on the multimeter is apparent throughout a wide adjustment of a component, *reduce the strength* of the signal introduced from the signal generator until a very sharp peak may be obtained by tuning the component being alined.

- (3) Disconnect the signal generator from T12.

*d. V20 Alinement.*

- (1) Connect Signal Generator AN/URM-25 at terminal 3 of T11. Set the generator to deliver an unmodulated 100-kc output.
- (2) Observing the precautions outlined in the note in c(2) above, alternately adjust the bottom and then the top slugs of T12 to obtain a sharply peaked reading on the electronic multimeter.
- (3) Disconnect the signal generator from T11.

*e. V19 Alinement.*

- (1) Connect Signal Generator AN/URM-25 at terminal 3 of T10. Set the generator to deliver an unmodulated 100-kc output.



- (2) Observe the precautions outlined in c(2) above and alternately adjust the bottom and then the top slug of T11 to obtain a sharply peaked reading on the electronic multimeter.
- (3) Disconnect both the signal generator and the electronic multimeter.

## 58. CARRIER LEVEL Meter Calibration for Sideband Level Correlation.

*a. General.* CARRIER LEVEL meter M2 is provided on the control panel of the equipment to indicate efficient input level to the carrier limiter strip. The level of this input signal may be varied by means of CARRIER COMPENSATOR control R112. Calibration of the CARRIER LEVEL meter consists of adjusting the meter to read midscale with an ideal signal existing at the output of each sideband if. strip.

*Note.* This calibration should not be undertaken prior to heterodyne oscillator tuning described in paragraph 60.

### *b. M2 Calibration.*

- (1) Apply a 1,000- $\mu$ v signal at a frequency of 455 kc (which represents the carrier signal) and a 10,000- $\mu$ v signal at 2,500 cycles higher (which represents the upper sideband signal) to the input of the converter.
- (2) Set the SB AGC control at 7.5 and the CARRIER COMPENSATOR control at 6.5.
- (3) Adjust the INPUT GAIN control until the output of FL1 (terminal 3 of T4) reads .1 volt on the electronic multimeter.
- (4) Change the sideband frequency to 2,500 cycles lower than the carrier signal and measure the signal level at terminal 3 of T7. This level should be within 3 db of that measured in c below. If a difference of more than 3 db exists between the two levels, troubleshooting in the mixer and if. stages should be undertaken as outlined in paragraph 41. Should either level exceed .1 volt, readjust the INPUT GAIN control to obtain the desired level.
- (5) Make sure the carriers signal is in the carrier channel (locked in on afc). Adjust the CARRIER METER ADJUST control for midscale reading (10) on the CARRIER LEVEL meter.

## 59. Alternate Method of CARRIER LEVEL Meter Adjustment

- a.* Connect Signal Generator AN/URM-25 at IF. INPUT receptacle J1. Set the generator to deliver an unmodulated 100-kc output.
- b.* Connect Electronic Multimeter ME-6A/U to measure dc voltages at the arm of R189.
- c.* Adjust the output level of the signal generator until the multimeter shows a reading of 65 volts dc.
- d.* Adjust CARRIER METER ADJUST control R190 for a half-scale reading on M2.
- e.* Disconnect the multimeter and the signal generator.

## 60. Heterodyne Oscillator Tuning

*a. General.* Heterodyne oscillator V2 has four elements in its tank circuit capable of varying the output frequency of the oscillator. Two of these elements, capacitors C10 and C13, are connected, respectively, to the VERNIER and DRIFT INDICATOR controls on the equipment front panel. Each of these controls is capable of varying the oscillator output frequency  $\pm 2$  kc from a center frequency, which is selected by the adjustment of the third variable element on the oscillator tank circuit, inductance L1. Inductance L1 determines the center frequency of the oscillator and is capable of varying the oscillator center frequency between 550 and 610 kc. This range makes it possible for the converter to be used with different receivers that have an if. output falling within the range of 450 through 510 kc. The alinement of the oscillator consists of setting its center frequency so that it will produce the output necessary to convert the if. delivered to the converter from the receiver to the 100-kc if. of the converter. The fourth variable element in the tank circuit, RANGE COMPENSATOR C8, is then adjusted to produce an LC ratio necessary to validate the front panel calibration markings of VERNIER control C10 and DRIFT INDICATOR C13.

### *b. Oscillator Center Frequency Setting.*

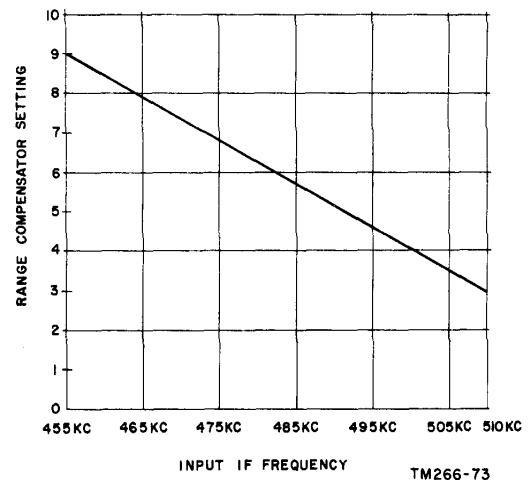
- (1) Set the converter front panel controls as instructed in paragraph 51.
- (2) Connect Signal Generator AN/URM-25 at IF. INPUT jack J1 (fig. 42).
- (3) Set the signal generator to deliver (unmodulated) the if. of the receiver with which the converter is intended to be used. For Radio Receiver R-390 URR, this frequency is 455 kc.

- (4) Set the amplitude of the signal to be delivered from the signal generator at 10,000 uv.
- (5) Use the alinement tool to adjust tuning slug L1 to obtain a peak reading of CARRIER LEVEL meter M2.

*Note.* When tightening the locking nut on the coil slug of L1, be sure not to turn the slug and thus detune the stage. Should the coil detune slightly in tightening the locking nut, it is practical to retune by a minor readjustment of the RANGE COMPENSATOR capacitor. However, this adjustment *should not be considered the normal tuning* of the heterodyne oscillator tank and should be used *only* as a final adjustment to the tuning, after the setting of the RANGE COMPENSATOR has been determined as outlined in *c* below.

*c. RANGE COMPENSATOR C8 Adjustment*  
(fig. 31).

- (1) Connect Frequency Meter FR-67/U at the end of R108 not connected to R109 (TB6, fig. 65).
- (2) Adjust the converter VERNIER control from the -2 KC to the +2 KC position. The frequency meter should indicate a change from 98 kc (in the -2 KC position) to 102 kc (in the +2 KC position).
- (3) If the adjustment of the VERNIER control produces a change of *less* than 4 kc, *decrease* the capacitance of RANGE COMPENSATOR control C8 by turning the screwdriver adjustment in a clockwise direction. Approximate settings for various if. input frequencies are given in figure 51.
- (4) If the VERNIER control produces a change of *more* than 4 kc, *increase* the capacitance of C8 by turning the adjustment in a counterclockwise direction.
- (5) After readjusting C8, restore the VERNIER control to 0 kc position and repeat the procedures given in *b* above. After readjusting L1, recheck the calibration of the VERNIER control and, if necessary, readjust both the RANGE COMPENSATOR control and L1 a second time.
- (6) After completing the adjustment of C8, disconnect the signal generator and the frequency meter.



**Figure 51. Range compensator control setting versus if. input frequency.**

## 61. Heterodyne Oscillator Adjustment for Centering If. of Associated Radio Receiver R-390/URR

Although Radio Receiver R-390/URR has a 455-kc if., the exact value of the center of the pass band from a particular receiver, when set in the 16 kc position, may be as much as 1,000 cycles removed from this value. To insure proper centering of the if. and prevent sideband clipping, the following method for adjusting the converter heterodyne oscillator should be followed:

- a. Set the converter controls as follows: VERNIER and DRIFT INDICATOR controls to the KC position and AFC control to the OFF position.
- b. Set the receiver BANDWIDTH control at the 16 KC position, with its FUNCTION switch at AGC. Set the converter AGC SELECT switch to REC.
- c. Apply an unmodulated signal (at any convenient frequency) to the antenna terminals of the receiver, and tune it for a maximum reading on the AGC meter of the receiver.
- d. Adjust the output of the signal source until the meter reads approximately 66.
- e. Vary the tuning knob of the receiver in one direction and then the other, and locate the position on each side where the level of the meter reads 60. Note the receiver dial readings at these positions.

f. Set the receiver tuning dial to the exact center of these readings.

g. Adjust the tuning slug of the converter heterodyne oscillator coil until the if. signal output of the receiver falls into the carrier channel, and indicates on the CARRIER LEVEL meter. The level of the signal that is applied to the carrier channel should be adjusted so that it is approximately half scale on the meter when this adjustment is made.

h. The converter is now properly adjusted for use with its particular receiver.

## 62. Local Carrier Oscillator Tuning

Lain local carrier oscillator V35 by comparing its output frequency against a primary standard; then adjust a trimmer capacitor (C148) in the tank circuit to establish the oscillator frequency at exactly 100 kc. To lain the stage, proceed as follows:

a. Set CARRIER SELECT switch S6 in the RC position. All other converter controls should be set as instructed in paragraph 51.

b. Connect Frequency Meter FR-67/U across resistor R133 (figs. 32 and 65).

c. Adjust C148 for an oscillator frequency of 100 kc, as indicated on the frequency meter. Use a nonmetallic alinement tool to make this adjustment.

d. Disconnect the frequency meter.

## 63. Afc Input Circuit Alinement

a. *General.* Two signals are delivered to the converter afc circuit. Both are tripled in frequency to enable the afc circuit to correct more frequency drifts. The alinement of the afc input circuit consists of resonating T14, through which the reconditioned carrier frequency is delivered, and T16, which couples the output of the local carrier oscillator, at 300 kc, which is triple the frequency fed to them.

b. *Tuning T14.* Transformer T14 forms the tuned plate load of V22. To tune this transformer proceed as follows:

- (1) Connect Signal Generator AN/URM-25 at the control grid (pin 1) of V22. Adjust the signal generator to deliver an unmodulated 300-kc output of 100,000  $\mu$ v.
- (2) Connect Electronic Multimeter ME-6A/U at the junction of R140 and R141 (fig. 35).

- (3) Remove the shield from the oscillator section, and remove HR1 (fig. 31) from its socket.
- (4) Use the alinement tool to adjust both tuning slugs of T14 for a peak reading on the meter.
- (5) Disconnect the signal generator from V22.

c. *Tuning T16.* Transformer T16 forms the plate load of tripler V35B. To tune this transformer, proceed as follows:

- (1) Remove afc gate tube V22.
- (2) Connect Signal Generator AN/URM-25 at the control grid (pin 9) of V35B. Adjust the signal generator to deliver an unmodulated 300-kc output at 2 volts.
- (3) Use the alinement tool to adjust both slugs of T16 for a peak reading on the meter, which remains connected as it was in b above.
- (4) Disconnect the signal generator and the multimeter. Replace V22 and HR1, and reinstall the shielding on the local carrier oscillator section.

## 64. Squelch Circuit Adjustments

a. *General.* The squelch circuit in the converter disables the afc circuit when the signal-to-noise voltage ratio falls below a level of 3 db. The adjustments in the circuit consists of three biasing controls, which fix the proper thresholds for the operation of the various electron tubes in the circuit.

b. *SQUELCH THRESHOLD Adjustment.*

The setting of SQUELCH THRESHOLD control R203 (fig. 31) establishes the bias on the control grid of afc gate tube V22, when SQUELCH switch S9 is in the ON position, and *the squelch circuit is inoperative*. For a satisfactory carrier signal input to the converter, the bias should be the same at the grid of V22 whether the SQUELCH switch is in the ON or OFF position. To establish this condition, proceed as follows:

- (1) Connect Signal Generator AN/URM-25 at the converter IF. INPUT jack J1 (fig. 42). Adjust the generator to deliver a 455-kc unmodulated input to the converter. Exact tuning of the generator is accomplished by obtaining a peak reading on the converter CARRIER LEVEL meter. After obtaining a peak, set the output level of the generator to produce

a midscale reading on the CARRIER LEVEL meter.

- (2) Set the front panel controls as instructed in paragraph 51.
- (3) Place NOISE SQUELCH control R194 and CARRIER FADE SQUELCH control R189 in their maximum clockwise position.
- (4) Connect Electronic Multimeter ME-6A/U, and adjust it to read negative dc voltages at the control grid (pin 1) of afc gate tube V22.
- (5) With the SQUELCH switch in the OFF position, note the reading on the multimeter.
- (6) Turn the SQUELCH switch to the ON position.
- (7) Adjust SQUELCH THRESHOLD control R203 to obtain the same reading as that in (5) above.
- (8) Disconnect the multimeter.

c. *CARRIER FADE SQUELCH Adjustment.*

The cathode circuit of carrier rectifier V32A is so designed that, in the absence of noise, the carrier may fade 26 db from a midscale reading of the CARRIER LEVEL meter, before squelch is applied. This is true when CARRIER FADE SQUELCH control R189 is turned fully clockwise, which is the normal position for this control. When readjusting the squelch circuit so that it will react to carrier fades of *less than* 26 db, follow the procedure below:

- (1) Turn the SQUELCH switch to the ON position. Allow all other controls to remain set as instructed in paragraph 51.
- (2) With the signal generator connected as in b(1) above, adjust its output level to give a midscale reading on the CARRIER LEVEL meter.
- (3) Note the output level of the signal that is delivered from the signal generator by observing the output level measuring device *on the generator*.
- (4) Reduce the signal generator output level the required number of db from this reference point.
- (5) Adjust CARRIER FADE SQUELCH control R189 until the SQUELCH ALARM lamp on the equipment front panel lights. Stop adjustment of R189 at the *exact point* where the alarm lamp lights.

d. *NOISE SQUELCH Adjustment.* To prevent the afc circuit from being falsely actuated by random noise introduced to the converter carrier section, the signal-to-noise voltage ratio must be maintained above a minimum of 3 db. The bias is adjusted on noise rectifier V32B so that squelch voltage will be applied whenever the signal-to-noise ratio drops below this desired level. Make this adjustment as follows:

- (1) Turn the SQUELCH switch to the ON position. All other front panel controls should remain set as instructed in paragraph 51.
- (2) Connect the signal generator as instructed in b(1) above. Adjust the output level of the generator to produce a midscale reading on the CARRIER LEVEL meter.
- (3) To simulate a noise signal, modulate the output of the signal generator 70 percent with 5 cps.
- (4) Adjust NOISE SQUELCH control R194 to the point where noise peaks just begin to operate the squelch circuit, as indicated by the SQUELCH ALARM lamp on the front panel.

## 65. VU METER Calibration

VU METER M1, on the equipment control panel, gives the converter operator an indication of the audio-output level that is being delivered from converter channels A and B to the associated carrier terminal equipment. The meter is calibrated to the standard *volume unit* transmission system, based on a reference level of 1 milliwatt (mw) in 600 ohms. To calibrate the meter, proceed as follows:

a. Set the VU SELECT switch to the A position. Set the other front panel controls as instructed in paragraph 51.

b. Connect a 300-ohm composition resistor between terminals 1 and 2 of TB1. Connect a second 300-ohm composition resistor between terminals 2 and 3 of TB1. This hookup simulates a balanced 600-ohm load.

c. Connect Electronic Multimeter ME-6A/U, set to read 1 volt or more, across either resistor.

d. Connect Audio Oscillator TS-382A/U at the control grid (pin 7) of V8B. Adjust the generator to deliver an output of 1.23 volts (as indicated on the multimeter) at 1,000 cps.

e. Set VU METER ADJUST control R51 to obtain a reading of 100 on VU METER M1.

f. Disconnect the multimeter and the signal generator.

## 66. Demodulator Bias Adjustment

a. *General.* Intermodulation between the various frequencies that are present in the demodulator stages of the converter must be held at a minimum to insure proper operation of the carrier terminal equipment with which the converter is used. Distortion, resulting in spurious audio frequencies being delivered to the terminal equipment, will cause it (and thus the teletypewriters fed from the terminal equipment) to react falsely. This condition will cause the intermittent loss of some characters in messages or intermodulation distortion occurring in the converter may prevent the reception of any intelligence. A large number of complex adjustments to reduce distortion in the converter audio output need not be made, because of the design of the demodulator circuits in the converter. Merely adjust the bias on the final (output) amplifier in the demodulator cascade of channel A and channel B. However, *this adjustment is very critical.* It should not be adjusted *experimentally* to straighten out garbled copy during operation of the equipment. Do not try to adjust the CHAN. A BIAS ADJUST and CHAN. B BIAS ADJUST controls unless the test equipment used is known to be in the best condition.

b. *Alternate Method for Adjusting Demodulator Bias.* Two methods are given in this paragraph for adjusting the bias on the demodulators. The second method (*d* below) is closest to the actual conditions under which the equipment operates. At the same time, it provides the necessary standards to make proper adjustment possible. This method should be used whenever the proper test equipment is available. The first method, which can be performed more rapidly, requires only one signal generator, and for most practical purposes is satisfactory.

c. *First Alternate Method for Adjusting Demodulator Bias.* This method for making the demodulator bias adjustment, though satisfactory in most cases, should not be used if the test equipment and time, necessary for performing the procedure described in *d* below are available. To obtain satisfactory results from the use of this method, a signal generator with linear modulation characteristics, and a very low hum content must be available.

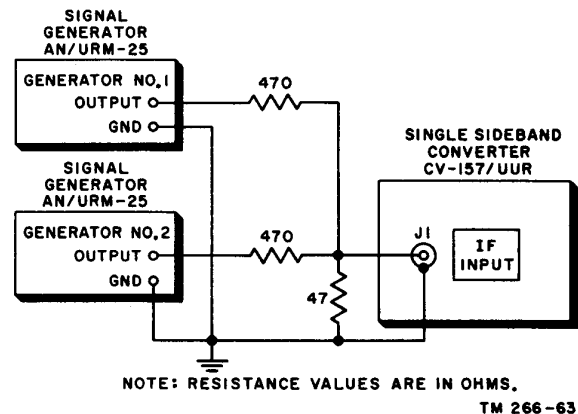


Figure 52. Converter input hookup for demodulator bias adjustment.

- (1) Set SB SELECT switch to A-LSB, B USB, the CARRIER SELECT switch to RC, the A-VC and B-VC controls maximum clockwise, and the CARRIER COMPENSATOR to O. Set all other controls as instructed in paragraph 51.
- (2) Set CHAN. A BIAS ADJUST and CHAN. B BIAS ADJUST controls, R41 and R86, respectively, midway between their extremes.
- (3) Terminate channel A with a simulated 600-ohm balanced load by connecting one 300-ohm composition resistor between terminals 1 and 2 of TB1, and another between terminals 2 and 3 (fig. 45).
- (4) Connect Signal Generator AN/URM-25 at the converter IF. INPUT receptacle J1. Adjust the signal generator to deliver a 453-kc output, modulated 30 percent with a 1,000-cps audio signal.
- (5) With the diode probe, connect Electronic Multi-meter ME-6A/U at terminal 3 of T4 (fig. 11 and 38).
- (6) Adjust the output level of the signal generator to produce a reading of .9 volt rf on the meter.
- (7) Disconnect the meter from T4, and reconnect it between terminals 1 and 3 of TB1. Adjust the meter to read on the lowest available ac scale.
- (8) Set CHAN. A BIAS ADJUST control R41 to obtain a minimum reading on the multimeter. A reading that approaches

zero will be obtained if the output of the signal generator is free of hum.

**Caution:** The reading should be obtained *somewhere between* the extremes of R41. Do not set the control to *the extreme* that yields the lowest apparent output at TB1.

- (9) Reset the signal generator to deliver a 457-kc output, modulated 30 percent with a 1-kc audio signal.
- (10) Disconnect the multimeter and the termination resistors from the channel A output terminals.
- (11) Reconnect one resistor between terminals 4 and 5 of TB1. Reconnect the other resistor between terminals 5 and 6 of TB1.
- (12) With the diode probe, connect the multimeter at terminal 3 of T7 (figs. 11 and 38).
- (13) Adjust the output level of the signal generator to produce a reading of .9-volt rf on the meter.
- (14) Reconnect the multimeter across terminals 4 and 6 of TB1.
- (15) Observe the precaution outlined under (8) above, and set CHAN. B BIAS ADJUST control R86 to obtain a minimum reading on the multimeter.
- (16) Disconnect the termination resistors, the multimeter, and the signal generator.

d. *Second Alternate Method for Adjusting Demodulator Bias.* This method is superior to that described in c above and whenever possible it should be used in preference to the first method.

- (1) Connect the two signal generators (fig. 52).
- (2) Connect Electronic Multimeter ME-6A/U at terminal 3 of T4 (fig. 38).
- (8) Connect a 300-ohm composition resistor between terminals 1 and 2 of TB1. Connect a second 300-ohm composition resistor between terminals 2 and 3.
- (4) Connect Sound Analyzer TS-615/U across one of the terminating resistors.
- (5) Set the SB SELECT switch in the A-LSB, B-USB position. Set the other front panel controls as directed in paragraph 51.
- (6) Set bias adjust controls R41 and R86 midway between their extremes.

- (7) Adjust signal generators Nos. 1 and 2 to deliver an output frequency of 453.2 kc and 452.7 kc, respectively.
- (8) Connect a multimeter to terminal 3 of T4.
- (9) Reduce the output amplitude of the signal delivered from signal generator No. 2 to 0 volt.
- (10) Adjust the output of signal generator No. 1 to produce a reading of .5 volt on the multimeter. Note the setting on the calibrated dial of the signal generator output attenuator.
- (11) Tune the sound analyzer to 1,800 cps.
- (12) Adjust the signal generator for a maximum indication on the sound analyzer.
- (13) Decrease the output amplitude of signal generator No. 1 to 0 volt.
- (14) Adjust the output amplitude of signal generator No. 2 for a reading of .5 volt on the multimeter.
- (15) Tune the sound analyzer to 2,300 cps.
- (16) Adjust signal generator No. 2 for a maximum indication on the sound analyzer.
- (17) Re-establish the output amplitude of signal generator No. 1 by running the attenuator control up to the setting noted in (10) above.
- (18) Adjust the A-VC control for a reading of 100 on the highest scale of the VU METER.
- (19) Tune the sound analyzer to 500 cps.
- (20) Adjust CHAN. A BIAS ADJUST potentiometer R41 for a minimum reading on the wave analyzer.

**Caution:** The minimum reading on the sound analyzer should be obtained between the extremes of R41. Do not set the control to *the extreme* that yields the lowest apparent reading on the sound analyzer.

- (21) Disconnect the sound analyzer, multimeter, and resistors.
- (22) Reconnect one resistor between terminals 4 and 5 and the other between terminals 5 and 6 of TB1.
- (23) Connect the sound analyzer across one of the terminating resistors.
- (24) Reconnect the multimeter to terminal 3 of TB7.
- (25) Reset signal generators No. 1 and 2

to deliver an output frequency of 456.8 kc and 457.3 kc, respectively.

- (26) Repeat the steps outlined in (9) through (17) above.
- (27) Adjust the B-VC control for a reading of 100 on the highest scale of the VU METER.
- (28) Tune the sound analyzer to 500 cps.
- (29) Observe the precaution under (20) above and adjust CHAN. B BIAS ADJUST control R86 for a minimum reading on the sound analyzer.
- (30) Disconnect the test equipment and the termination resistors.

## 67. Agc Circuit Adjustment

a. *General.* There are three controls which must be adjusted for proper operation of the agc converter circuit. These are C94, AGC THRESHOLD control, and AGC OUTPUT control. Capacitor C94 fixes the relationship between carrier level and sideband level, which are applied to the agc circuit in the converter. Thus, with a given amount of carrier reduction, sideband and carrier can have equal effects on the agc output voltage of the converter. This permits control of the receiver agc circuit by either the carrier or a sideband. Such flexibility allows the most critical component of the incoming signal to be held to a nearly constant amplitude at the input to the converter. Either the carrier or a sideband may be selected to control the age, without seriously disturbing the average operating amplitude of the other signal. Converter AGC OUTPUT control R228 and AGC THRESHOLD control R231 adjust the agc output voltage with respect to if. input voltage characteristic curve of the converter. The agc characteristics of the converter must be made to operate with those of the receiver if the input to the converter is to be held nearly constant.

b. *Simulating a Single-sideband Signal.* Any sideband signal may be defined by separating its frequency components and describing the absolute, as well as the relative, amplitudes. The alinement procedure (*c* below) equalizes the agc voltages developed by a sideband signal and a carrier signal within the converter. A single-sideband signal can be simulated by controlling the relative frequency and amplitude of a signal generator, thus generating the individual components of the composite signal. The converter differentiates between sideband and carrier signals with filter networks. The

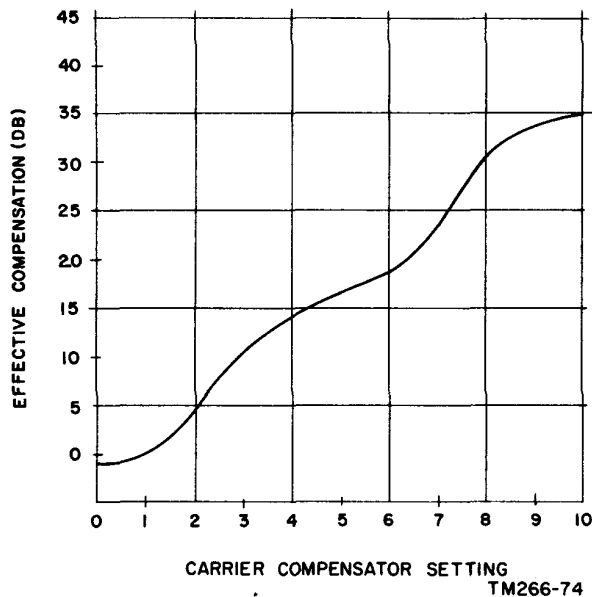
alinement procedure (*e* below) equalizes the agc voltage that is developed by the converter and the receiver. A receiver develops agc voltage on the basis of a rectified signal. The receiver will rectify all frequency components within its pass band. The amplitude of the agc voltage developed by the receiver will then be the *sum* of the amplitudes of the frequency components present. The converter develops agc voltage on the basis of *individual* components of a composite sideband signal. The amplitude of the signal generator must be controlled to emphasize the sideband signal, when the receiver agc voltage is referenced. This is necessary to simulate the amplitude of the composite signal within the receiver.

c. *C94 Adjustment.* The purpose of C94 adjustment is the equalization of sideband and carrier agc voltages.

- (1) Set SB AGC control to 7.5; set the AGC SELECT switch to the USB position; set the CARRIER COMPENSATOR to 6.5 (fig. 53). Set the other front panel controls as instructed in paragraph 51.
- (2) Connect the signal generator to IF. INPUT jack J1. Set INPUT GAIN control R2 at maximum. Adjust the signal generator to 455 kc, and set its output to 1,000 uv. This represents a *carrier* signal, which is suppressed 20 db.
- (3) Tune in the signal with the converter VERNIER control. Adjusting the VERNIER control about the zero mark will produce a maximum on the CARRIER LEVEL meter. Adjust the CARRIER COMPENSATOR control for a midscale reading on the CARRIER LEVEL meter.
- (4) Readjust the signal generator to 458 kc, and set its output to 10,000 uv. This represents a *sideband* signal.
- (5) With the electronic multimeter adjusted to measure negative dc voltage, measure the agc voltage output of the converter at terminal 7 of TB2.
- (6) Restore the *carrier* signal to the converter input by adjusting the signal generator to 1,000 uv at 455 kc. Set the AGC SELECT switch to the CAR position.
- (7) Adjust C94 for the same dc (agc) voltage as that measured in (5) above. Capacitor

C94 is adjusted through an access hole on the rear chassis apron.

- (8) Compensate for any detuning of T10 by adjusting the bottom (primary tuning) slug for a maximum on the CARRIER LEVEL meter



**Figure 53. Effective Compensation versus carrier compensator control setting**

*d. INPUT GAIN Adjustment.* Proper adjustment of the INPUT GAIN control is necessary to provide the converter circuits with the levels required for optimum performance, including correct agc characteristics and minimum distortion in the output signal. The input level requirements of the converter are met through the adjustment of INPUT GAIN control R2. Once this level is established, it is maintained virtually constant by the converter agc circuits. Set the INPUT GAIN control as follows:

- (1) Connect Signal Generator AN/URM-25, matched to the input impedance of the converter, at IF. INPUT jack J1 (fig. 42). Adjust the generator to deliver a 455-kc unmodulated signal of 5,000 uv to the converter.
- (2) Center the operation of the converter, feeding this input signal through the carrier channel, and lock the converter to the signal with the afc action.
- (3) Set the CARRIER COMPENSATOR at 6.5.

- (4) Adjust the INPUT GAIN control for a reading of 10 on the CARRIER LEVEL meter. This setting should not be changed during subsequent adjustment of the agc circuits.

*e. AGC OUTPUT and AGC THRESHOLD Adjustments.* The purpose of these adjustments is to match receiver and converter agc characteristics.

- (1) Connect Radio Receiver R-390/URR to converter (fig. 54). After sufficient warming time, calibrate the receiver, and tune it to 4,000 kc. Set the BFO switch to OFF, the AGC switch to FAST, the FUNCTION switch to AGC, the BANDWIDTH switch to 8 kc, and the RF GAIN at maximum. The setting of the remainder of the receiver controls does not affect this adjustment.
- (2) Set the converter AGC SELECT switch to REC. Set the other converter controls as in c above.
- (3) Connect Signal Generator AN/URM-25, modified to represent a 125-ohm source, between one terminal of J108 of the receiver and ground. A 50-ohm signal generator may be provided with a 75-ohm building-out resistor to give a 125-ohm source impedance (fig. 54).
- (4) Connect the electronic multimeter (adjusted to measure negative dc voltage) to terminal 7 of TB2 on the converter. With the signal generator tuned to a sideband frequency of 4,003 kc, increase its output from zero, while observing the receiver agc voltage that is indicated by the electronic multimeter. When the measured voltage increases approximately .25 volt, the receiver agc circuit becomes effective. This agc threshold point should occur with a signal input of only a few uv, if the receiver sensitivity is normal. Note the signal generator output voltage for the receiver agc threshold point.
- (5) With the AGC SELECT switch in the REC position, increase the signal generator output to 550 millivolts (mv). This simulates the amplitude of the composite signal in the receiver agc circuit. Note the voltage measured on the electronic multimeter. This is the agc voltage developed by the receiver.



- (6) Reduce the signal generator output to 500 mv. This simulates the amplitude of the composite signal in one sideband channel of the converter. Individual channels act on the converter sideband agc circuit separately. Set the AGC SELECT switch to the USB position. Adjust AGC OUTPUT R228 for a voltage reading 1 volt greater than the reading on the electronic multimeter as measured in (5) above. Resistor R228 is located on the rear chassis apron of the converter.

*Note.* On some units, since differences exist between acceptable tubes, it may not be possible to obtain this higher dc level. These units should be adjusted so that the minimum level obtained in this step is at least equal to the receiver agc voltage measured in (5) above.

- (7) Reduce the signal generator output to the value noted in (4) above. Set the converter AGC SELECT switch to the REC position. Note the voltage measured on the electronic multimeter. This agc voltage is developed by the receiver at the threshold point of agc action, as a result of a composite input signal.
- (8) Reduce the signal generator output to 90 percent of the value noted in (4) above. This simulates the amplitude of the composite signal in one sideband channel of the converter. The converter sideband agc voltage is a function of the energy that is filtered into one sideband channel. Set the converter AGC SELECT switch to the USB position. Adjust AGC THRESHOLD control R231 for the same

voltage reading on the electronic multimeter as was measured in (7) above. Control R231 is on the rear apron of the converter chassis.

- (9) Repeat steps outlined in (5) and (6) above, and adjust the AGC OUTPUT control. Repeat steps outlined in (7) and (8) above, and adjust the AGC THRESHOLD control.

## 68. A-VC and B-VC Adjustments

Volume control adjustments are made with the audio output of the converter feeding terminal equipment. The input requirements of the terminal equipment must be determined by consulting the manual that covers that particular equipment. Loss or gain in interconnecting pads, long lines, or amplifiers, must be considered in determining the output requirements of the converter.

a. With the terminal equipment connected for normal operation, use a test setup (fig. 54 and par. 67 e). Set the converter SB SELECT switch to the LSB-B, USB-A position. Set the converter VU RANGE switch to the value dictated by the operating conditions, and set the converter CARRIER SELECT switch to the LC position.

b. Adjust the signal generator output for 1,000 uv at 4,003 kc. Set the AGC SELECT switch to USB, the SB AGC control to 7.5, the VU SELECT switch to A, and adjust the A-VC control for a VU METER reading as determined by the operating conditions.

c. Adjust the signal generator output for 1,000 uv at 3,997 kc. Set the AGC SELECT switch to LSB, the VU SELECT switch to B, and adjust the B-VC control for a VU METER reading as determined by the operating conditions..

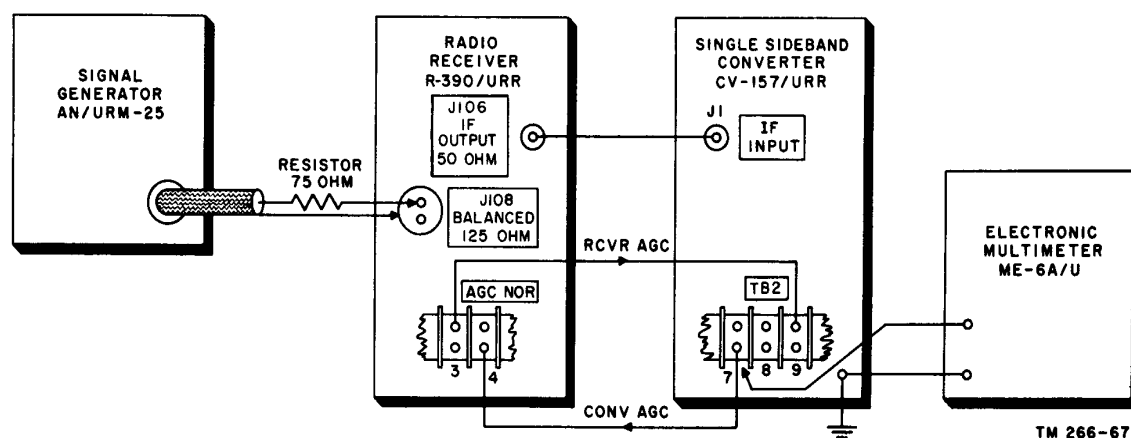


Figure 54. Hookup for agc circuit balance adjustments.

## CHAPTER 6 FINAL TESTING

### 69. General

This section serves as a guide in determining the quality of a repaired single-sideband converter. The minimum test requirements outlined in the following paragraphs may be performed by maintenance personnel with adequate test equipment and the necessary skills. Repaired equipment meeting these requirements will furnish uniformly satisfactory results during operation. The tests given in paragraphs 70 through 78 should be performed in the order given. Before performing any of the tests, however, the B+ and B- voltages should be checked as instructed in paragraph 39. The test equipment required to complete the converter alignment is listed in the chart in paragraph 37. The manual numbers for this test equipment are also listed.

### 70. Frequency Response Tests

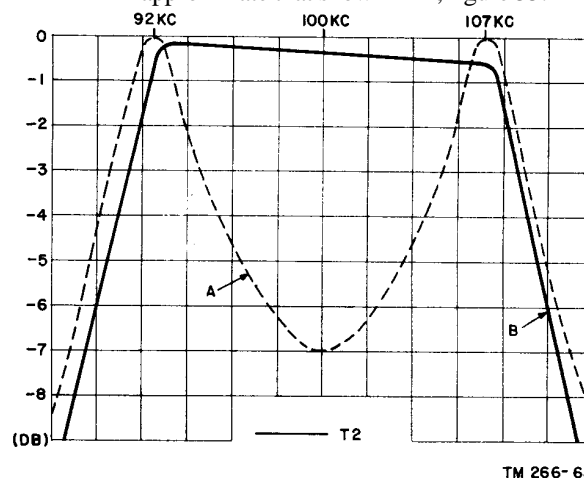
a. *General.* The converter consists of a large number of amplifying and filter circuits that have various characteristics of frequency response, depending on the function of the individual circuit. To determine if critical circuits in the converter have the response characteristics necessary for the proper operation of the converter, follow the procedures below and in paragraph 71.

b. *Preliminary Procedures.*

- (1) Connect Signal Generator AN/URM-25 at converter IF. INPUT receptacle J1.
- (2) Turn on the converter and the signal generator and allow them to warm for at least 15 minutes.
- (3) Set the converter VERNIER and DRIFT INDICATOR controls at 0. Other front panel controls settings have no effect on these tests.
- (4) Set the signal generator to deliver R 100-kc unmodulated output at 10,000  $\mu$ v.
- (5) Connect Electronic Multimeter ME-6A/U between the plate (pin 5) of V3 and ground by using the diode test probe.
- (6) Connect a 4,700-ohm resistor between terminals 1 and 2 of T2.

c. *Frequency Response Checks of Input Stages.*

- (1) Vary the signal generator between 90 and 110 kc. The curve, as indicated by the readings obtained on the multimeter, should approximate that shown in A, figure 55.



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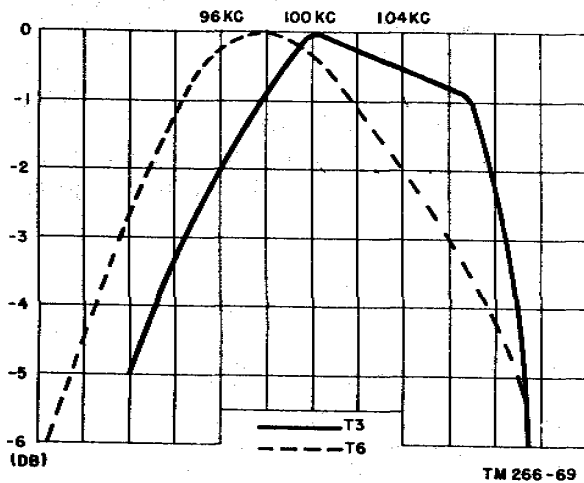
**Figure 55. Converter frequency response from INPUT jack J1 to output of T1 and T2.**

- (2) Disconnect the multimeter from V3 and reconnect it at the plate (pin 5) of carrier if. amplifier V16. Disconnect the resistor from terminals 1 and 2 of T2.
- (3) Again, vary the output of the signal generator between 90 and 110 kc. The readings obtained on the multimeter should approximate the response curve that is illustrated in B, figure 55. (This represents the combined response of T1 and T2.)
- (4) If T1 and T2 fail to meet the response curves set forth in figure 55, the stages should be realigned (par. 53).

d. *Sideband If. Amplifier Frequency Response Tests.*

- (1) Connect the multimeter at terminal 1 of FL1 (figs. 38 and 39).

- (2) Vary the signal generator output between 98 and 108 kc. The readings obtained on the multimeter should approximate curve illustrated in A, figure 56.
- (3) Disconnect the multimeter and reconnect it at terminal 1 of FL3 (figs. 38 and 39).
- (4) Vary the signal generator output frequency between 92 and 102 kc. The readings obtained on the multimeter should approximate those illustrated in B, Figure 56.



**Figure 56. Converter frequency response from input jack J1 to output of T3 and T6.**

- (5) Failure of T3 or T6 to provide the desired response indicates that the stages should be realigned as instructed in paragraph 54.
- e. *Sideband and Carrier Filter Response Tests.*
- (1) Connect the converter, Signal Generator AN/URM-25, and Frequency Meter FR-67/U as shown in figure 57.
  - (2) Allow the equipment to warm for 15 minutes.
  - (3) Adjust the signal generator to deliver the if. output of the receiver with which the converter is to be used. The output of the generator should be unmodulated with an amplitude of 10,000 uv.
  - (4) (Connect the electronic multimeter at terminal 2 of S1 (fig. 32). Use the meter diode probe.
  - (5) Tune the converter to the input signal delivered from the signal generator.
  - (6) Adjust the CARRIER COMPENSATOR

control for a midscale reading on the CARRIER LEVEL meter.

- (7) Turn AFC switch S7 to ON.
- (8) With the SB SELECT switch in the A-LSB, B-USB position, note the reading on the multimeter. Establish this reading as 0 db for converter upper side band filter FL1.
- (9) Turn the SB SELECT switch to the LSB-B, USB-A position and note the reading obtained on the multimeter. Establish this reading as 0 db for converter lower sideband filter FL3.
- (10) Turn the AFC switch to OFF.
- (11) Increase the out put frequency of the signal generator 2 kc as calibrated by the frequency meter.
- (12) The multimeter should indicate an increase of at least 13 db over the level previously obtained for converter low sideband filter FL3.
- (13) Turn the SB SELECT switch to the A-LSB and B-USB position.
- (14) Decrease the output frequency of the signal generator 2 kc below its *original* reference frequency established in (3) above.
- (15) The multimeter should indicate an increase of at least 13 db over the level previously obtained for converter upper sideband filter FL1.
- (16) As a further check, the signal generator may be varied beyond the pass band of the sideband filters. Characteristic curves for these filters are shown in figure 58.
- (17) Disconnect the multimeter from S1 and reconnect it at terminal 3 of T10 (fig. 31).
- (18) Reset the signal generator to deliver a 100-kc unmodulated output at 30 uv.
- (19) Set the CARRIER COMPENSATOR control for a reading of .5-volt rf on the multimeter.
- (20) Proceed according to the chart below. The filter response curve should be at least as sharp as indicated in the table. At the highest and the lowest output frequencies of the signal generator increase the output level 40 db above the original 30 uv. The output reading on the multimeter should be at least 70 db below the original .5-volt rf reading. A characteristic response curve for carrier filter FL5 is shown in figure 59.

Output freq of sig gen (kc)	Level as indicated on multimeter (db)	output freq of sig gen (kc)	Level as indicated on multimeter (db)
100.000	-5.	100.000	-5
100.010	-5.5	99.994	-5.5
100.010	-6	99.992	-6
100.019	-8	99.988	-8
100.021	-10	99.984	-10
100.024	-15	99.981	-15
100.027	-20	99.979	-20
100.031	-25	99.975	-25
100.037	-30	99.970	-30
100.041	-36	99.966	-35
100.045	-40	99.966	-40
100.053	-45	99.955	-45
100.060	-50	99.949	-50
100.070	-55	99.940	-55
100.078	-60	99.933	-60
100.090	-65	99.922	-65
100.100	-68.5	99.920	-66
100.103	-70	99.912	-70
100.129	-75	99.895	-75
100.174	-79	99.870	-79

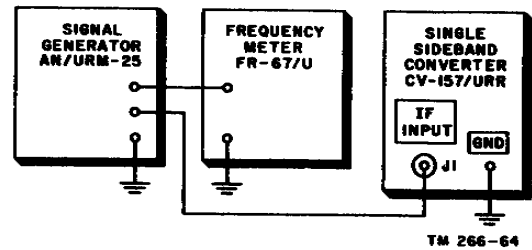


Figure 57. Connection for testing converter sideband and carrier filters

- (21) Failure of any of these filters to meet their performance standards may be attributed to failure of the components in the input or output circuits of the filters, or to failure of the filters. Because of the critical and complex nature of these filters, they cannot be repaired; replace them.

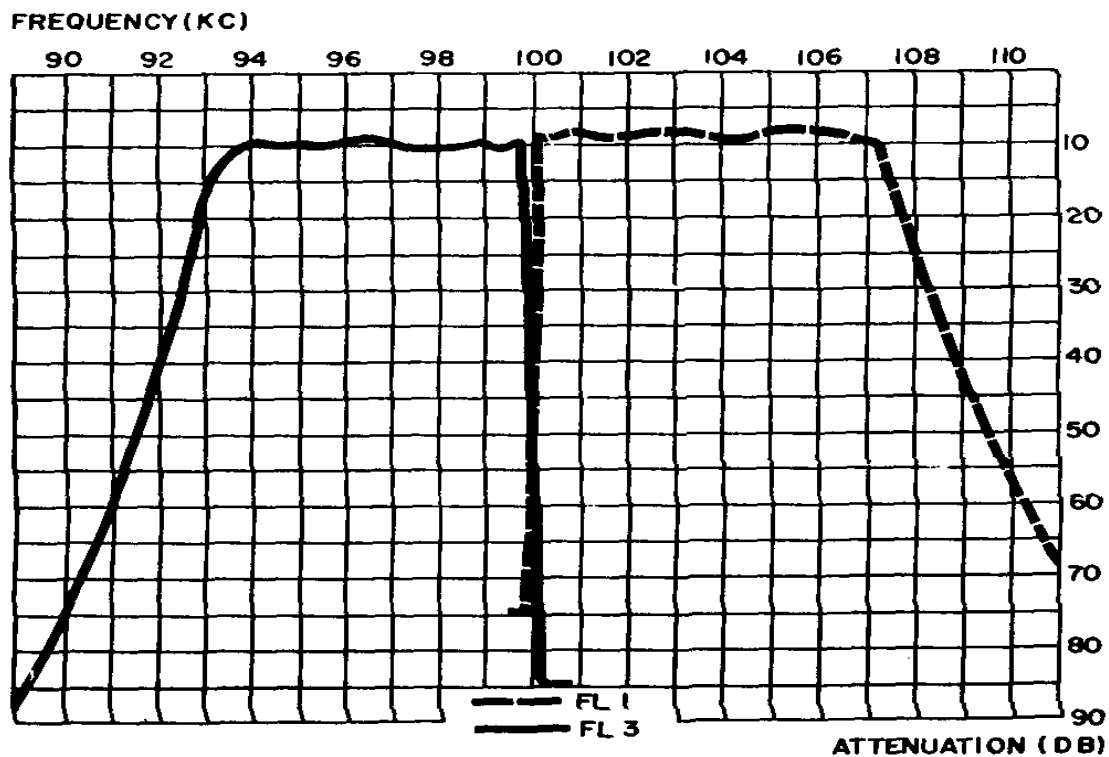


Figure 58. Characteristic frequency response curves of converter upper sideband filter FL1 and converter lower sideband filter FL3.

## 71. Testing Output Circuit Frequency Response Characteristics

*a. General.* The converter audio output and demodulator circuits must be checked to determine their rejection of unwanted frequency products as well as their overall response to desired frequencies. To test the characteristics of the converter audio circuits, proceed as follows:

### *b. Preliminary Procedures*

- (1) Connect the converter and test equipment as shown in figure 60.
- (2) Turn on the equipment, and allow 15 minutes for it to warm.
- (3) Connect the multimeter to terminal 3 of T7.
- (4) Feed 10,000  $\mu$ V from signal generator No 2 at a frequency 300 cps higher than the receiver if.
- (5) Adjust the INPUT GAIN control for a reading of .1 volt on the multimeter.
- (6) Disconnect the multimeter from T7.
- (7) Set signal generator No. 1 to deliver the if. of the receiver with which the converter is to be used. This signal should be unmodulated at 1,000  $\mu$ V.
- (8) Increase the output of signal generator No. 2 to 50,000  $\mu$ V.
- (9) Set signal generator No. 3 to deliver a 50,000- $\mu$ V unmodulated output at a frequency 800 cps higher than that of generator No. 1.
- (10) Turn the SB SELECT switch to the A-LSB, B-USB position, the CARRIER SELECT switch to LC, the SQUELCH switch to OFF, the CARRIER COMPENSATOR control for a midscale reading on the CARRIER LEVEL meter, and the AFC switch to ON.

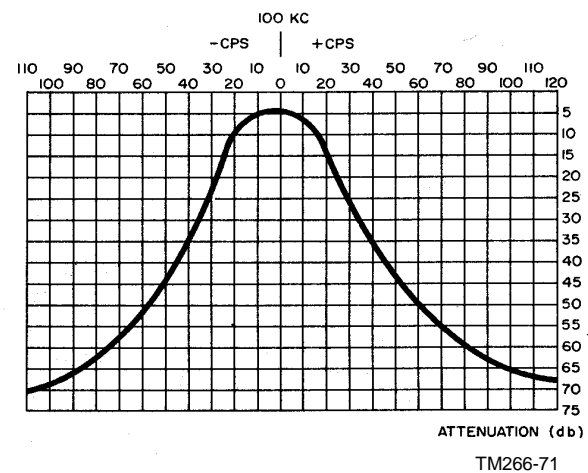
### *c. Channel B Intermodulation Distortion Test.*

- (1) Adjust the B-VC control to produce a 10-milliwatt output (1.225 volts ac as indicated on the multimeter).
- (2) Tune the sound analyzer to 300 and 800 cps and note the levels obtained. The two levels should be equal. Record this level as a reference of 0 db.
- (3) Proceed to tune the sound analyzer to the various intermodulation components according to the chart below. Change the input frequencies delivered by signal generators Nos. 2 and 3 where indicated.

### *d. Channel A Intermodulation Distortion Test.*

- (1) Disconnect the sound analyzer and multimeter from terminal 4 of TB1 and reconnect them at terminal 1 of TB1.

Input freq (higher than that of gen No. 1 by amount listed)		Fundamental output from converter audio channels (cps)		Tune sound analyzer to intermodulation component freq (cps)	Component should be below fundamental by at least (db)
Gen No. 2	Gen No. 3				
300 cps	800 cps	300	800	200	-63
				500	-55
				600	-58
				1,300	-50
900 cps	1.4 kc	900	1,400	400	-52
				500	-56
				1,800	-59
				1,900	-55
1.8 kc	2.3 kc	1,800	2,300	2,300	-53
				500	-48
				1,300	-60
				2,800	-53
5 kc	5.5 kc	5,000	5,500	3,600	-55
				500	-62
				4,500	-53
				6,000	-55



**Figure 59. Frequency response characteristics of carrier filter FL5.**

- (2) Turn the SB SELECT switch to the LSB-B, USB-A position
- (3) Adjust the A-VC control to produce a 10-milliwatt output (1.225 volts ac as indicated on the multi-meter).
- (4) Repeat the procedure in c (2) and (3) above.

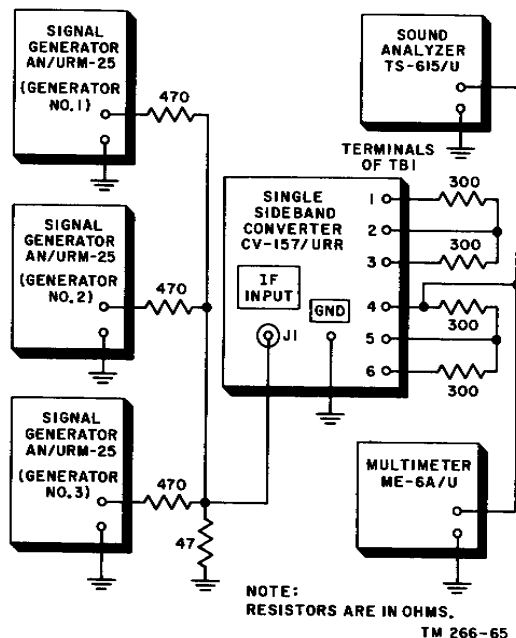


Figure 60. Connections for testing converter intermodulation distortion

e. AF Response Tests.

- (1) Connect the test equipment to the converter (fig. 61)
- (2) Turn on the equipment and allow it at least a 15-minute warming period.
- (3) Set the converter front panel controls as follows: CARRIER SELECT switch to LC, CARRIER COMPENSATOR to 6.5, SQUELCH to OFF; AFC switch to ON; SB SELECT switch to A-LSB, B-USB.
- (4) Place the LOWPASS FILTER switch in the OUT position.
- (5) Set generator No. 1 to deliver a 10,000-uv output at the if. of the receiver with which the converter is to be used.
- (6) Set generator No. 2 to deliver an unmodulated output at a frequency 1 kc lower than that of generator No. 1. The output amplitude of this signal should be 100,000 uv.
- (7) Adjust the A-VC control for a reading of 3.875 volts ac on the multimeter. This represents 100 milliwatts into a 600-ohm load and is taken as the 0-db reference in the chart below. Proceed as follows, holding the output amplitude of

signal generator No. 2 at 100,000 uv for the various frequencies indicated:

Gen No. 2 output freq displacement (freq of gen No. 1 Fixed) (kc)	Converter audio-out- put freq as indicated on sound analyzer (cps)	Output as indicated by multimeter reading (db)
-1	1,000	0
-.05	50	-3.1
-.1	100	-1.2
-.2	200	-1.2
-.3	300	-1.1
-.4	400	-1.0
-.5	500	-.3
-1	1,000	0
-1.5	1,500	-.3
-2	2,000	-.3
-3	3,000	-.2
-4	4,000	0
-5	5,000	-.8
-5.5	5,500	-1.1
-6	6,000	-1.0
-9	9,000	-51.5

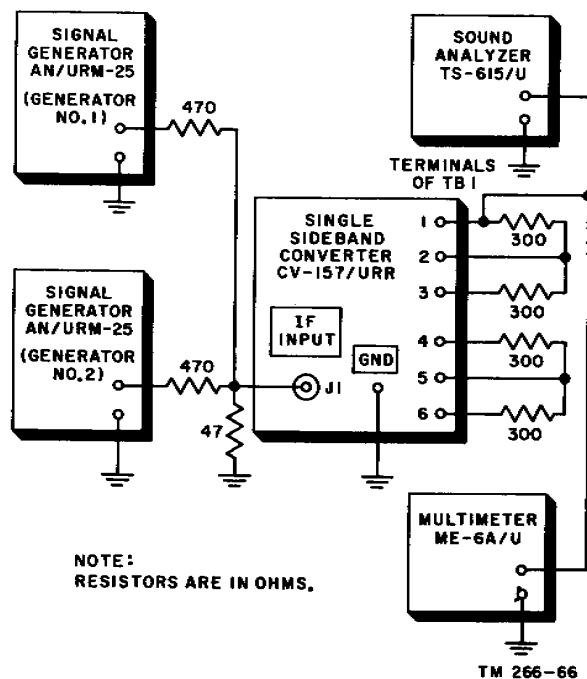


Figure 61. Connections for testing converter af response.

- (8) Place the LOWPASS FILTER switch in the IN position and proceed according chart below.

Gen No. 2 output freq displacement (freq of gen No. 1 Fixed) (kc)	Converter audio-output freq as indicated on sound analyzer (cps)	Output as indicated by multimeter reading (db)
-1	1,000	0
-.05	50	-3.0
-.1	100	-1.0
-.2	200	-1.0
-.3	300	-1.0
-.4	400	-.4
-.5	500	-.2
-1	1,000	0
-1.5	1,500	-.2
-2	2,000	-.2
-2.5	2,500	-.9
-3	3,000	-.9
-3.5	3,500	-.2
-4	4,000	-38
-4.2	4,200	-59

- (9) Disconnect the sound analyzer and multimeter from the channel A output and reconnect them at terminal 4 of TB1.
- (10) Set generator No. 2 to deliver an unmodulated output at the frequency of generator No. 1+1 kc. The output amplitude of this signal should be 100,000 uv.
- (11) Repeat the procedures outlined in (7) and (8) above.

*f. Conclusions.* Tolerances of  $\pm 1$  db from the response levels indicated in the charts above may be accepted. Intermodulation distortion products at least 45 db down from the fundamental. Failure of the converter to meet the specifications may be caused by maladjustment of the CHAN. A BIAS ADJUST and CHAN. B BIAS ADJUST controls in the affected channel. Instructions for adjusting these controls are given in paragraph 66. If, after the controls have been adjusted, the equipment still fails to meet the inter-modulation distortion specifications as indicated demodulator and output amplifying stages in the appropriate channel should be serviced. If final testing of demodulator and output amplifying stages reveals no source of responsibility for failure of the converter to meet overall audio response specifications, the if. Amplifier transformers should be checked for correct alignment outlined in paragraph 54.

## 72. Local Carrier Oscillator Frequency Check

- Connect Frequency Meter FR-67/U at terminal 6 of S6.
- Turn on the converter and the frequency meter and allow 10 minutes for the equipment to warm. Place the CARRIER SELECT switch in the LC position.
- Check the output frequency of the oscillator. It should be within 1 cps of 100 kc.
- Allow the equipment to remain operative for 1 hour. The output frequency of the oscillator, as indicated by the frequency meter, should remain within 1 cps of 100 kc.
- At this time check the output voltage of the oscillator (between terminal 3 of T15 and ground); use Electronic Multimeter ME ME-6A/U. This volt should be approximately 6 volts rf.
- Instructions for correcting the frequency of V35 are contained in paragraph 62.

## 73. Afc Circuit Tests

The tests for the converter afc circuit determine if the pull-in range of the circuit is satisfactory and if the circuit will track frequency changes at a satisfactory rate.

- Afc Pull-in Range Test.*
  - Connect Signal Generator AN/URM-25 at the converter IF. INPUT jack, J1. Adjust the signal generator to deliver an unmodulated 1,000-uv output at the if. Of the receiver with which the converter is to be used.
  - Tune the converter to this input signal.
  - Adjust the CARRIER COMPENSATOR control for a midscale reading on the CARRIER LEVEL meter.
  - Turn the AFC switch to ON and the SQUELCH switch to OFF.
  - Disconnect the signal generator and re-tune it 50 cps below the frequency used in (1) above.
  - Reconnect the signal generator. The CARRIER LEVEL meter should return to midscale within 2 seconds of the reinsertion of the new carrier frequency.
  - Disconnect the signal generator and retune it to the frequency used in (1) above.
  - Reconnect the signal generator. The CARRIER LEVEL meter again should read midscale within 2 seconds after the carrier is reinserted.

- (9) Repeat this procedure, tuning the signal generator 50 cps above the carrier frequency.

*b. Afc Tracking Test.*

- (1) Connect the signal generator at IF. INPUT jack J1. Set the generator to deliver the if. of the receiver with which the converter is to be used. The signal should be at 1,000-uv amplitude, unmodulated.
- (2) Tune the converter to this input signal.
- (3) Adjust the CARRIER COMPENSATOR control for a midscale reading on the CARRIER LEVEL meter.
- (4) Turn the AFC switch to ON. Allow the SQUELCH switch to remain OFF.
- (5) Vary the output of the signal generator at a rate of approximately 10 cps to a frequency 2 kc above the reference frequency established in (1) above. The CARRIER LEVEL meter should remain at midscale throughout this change.
- (6) Return the signal generator output frequency to the reference point and retune the converter.
- (7) Vary the output of the signal generator at a rate of approximately 10 cps to a frequency 2 kc below the reference level. The CARRIER LEVEL meter should remain at midscale throughout this change.

*c. Conclusions.* If the converter fails to meet either of these specifications (after meeting those preceding it) there is a failure present in the afc circuit. The afc circuit should be serviced (par. 48).

## 74. VERNIER Control Calibration Test

The VERNIER control is capable of causing a 2-kc deviation either side of the heterodyne oscillator center frequency. When this control is correctly calibrated, the DRIFT INDICATOR control, which also influences the frequency of the heterodyne oscillator, may be presumed also to be properly calibrated.

*a. Preliminary Procedures.*

- (1) Connect the converter and its test equipment as shown in figure 57.
- (2) Set the signal generator to deliver the if. output of the receiver with which the converter is to be used. The signal should be at 10,000 uv, unmodulated.
- (3) Turn the equipment on and allow 15 minutes for it to warm.

- (4) Set the converter front panel controls as follows: AFC switch to OFF; CARRIER COMPENSATOR to 0; CARRIER SELECT switch to LC; VERNIER and DRIFT INDICATOR controls at 0 (center).
- (5) Note the output frequency of the signal generator as indicated on the frequency. meter. Correct this output frequency, if necessary.

*b. Testing Procedures.*

- (1) Turn the VERNIER control to the -2 KC position.
- (2) Adjust the tuning of the signal generator for a maximum indication on the CARRIER LEVEL meter.
- (3) Note the output frequency of the signal generator as indicated by the frequency meter. The amount of calibration error should not exceed 200 cps.
- (4) Return the VERNIER control to the +2 KC position.
- (5) Retune the signal generator for a maximum indication on the CARRIER LEVEL meter.
- (6) The amount of calibration error present should not exceed 200 cps.

*c. Conclusions.* If the calibration error in the VERNIER control exceeds the limits indicated above, readjust the RANGE COMPENSATOR control as instructed in paragraph 60 c.

## 75. VU METER Calibration Check

The circuit constants in the converter are such that if the VU METER is calibrated correctly in one of the ranges, it will be correctly calibrated in its other ranges. To check the calibration of the VU METER, proceed as follows:

*a.* Connect Signal Generator AN/URM-25 at converter IF. INPUT jack J1. Adjust the generator to deliver an unmodulated signal 1 kc above the if. center of the receiver with which the converter is to be used.

*b.* Connect a 300-ohm composition resistor between terminals 1 and 2 of TB1. Connect a second 300-ohm resistor between terminals 2 and 3.

*c.* Connect Electronic Multimeter ME-6A/U between terminal 1 of TB1 and ground.

*d.* Set the converter front panel controls as follows: AFC switch to OFF; VERNIER and



DRIFT INDICATOR controls to 0 KC, CARRIER SELECT switch to LC, SB SELECT to A-LSB, B-USB, VU SELECT to A, and VU RANGE to + 10DB.

e. Adjust the output level of the signal generator for a reading of 100 on the VU METER.

f. The multimeter should show a reading of 1.23 volts ac.

g. If the VU METER fails to meet this specification, it may be recalibrated by following the instructions in paragraph 65.

## 76. Squelch Circuit Check

To check the operation of the squelch circuit and the SQUELCH ALARM lamp, proceed as follows:

a. Connect Signal Generator AN/URM-25 at the converter IF INPUT jack J1. Set the generator to deliver the unmodulated if. center of the receiver with which the converter is to be used. The output amplitude of the generator should be 1,000 uv.

b. Set the converter front panel controls as follows: AFC switch to ON, VERNIER for a maximum indication on the CARRIER LEVEL meter, SQUELCH to ON, and CARRIER COMPENSATOR for a midscale reading on the CARRIER LEVEL meter. Other front panel control settings are unimportant.

c. Turn on the equipment and allow it to warm for 15 minutes.

d. Decrease the setting of the signal generator attenuator control. The SQUELCH ALARM lamp should light when the input signal drops to about 30 microvolts, unless the squelch circuit *has been readjusted to a higher threshold* (par. 64). In this event, the SQUELCH ALARM lamp will light at a higher output level from the signal generator.

e. Vary VERNIER control. The AFC INDICATOR

and DRIFT INDICATOR control should show no evidence of tracking.

f. Return the VERNIER control to its tuned position.

g. Re-establish the mid-scale reading of the CARRIER LEVEL meter.

h. The SQUELCH ALARM should be extinguished.

i. If the squelch circuit shows evidence of trouble by failing to meet the requirements of this check, refer to the troubleshooting chart (par. 41) for possible remedies.

## 77. AFC DRIFT ALARM Check

To test the AFC DRIFT ALARM, proceed as follows:

a. Turn the DRIFT to the -2 KC position. The DRIFT AT ALARM lamp should light.

b. Turn the DRIFT INDICATOR control knob to the +2 KC position. The DRIFT ALARM lamp should light.

c. If the DRIFT ALARM lamp fails to light, check the lamp and microswitch S8.

## 78. Agc Circuit Tests

The adjustments made in the agc circuit change each time the receiver with which the converter is used changes. For this reason, adjustment of the age circuit forms part of the installation procedure for the converter. After this converter is reconditioned at the depot level for shipment to the field the age circuit should be adjusted to match a Radio Receiver R-390/URR that is known to be in good condition. Instructions for making the adjustments are given in paragraph 67. If these adjustments can be made, the age circuit may be assumed to be in working order. If the necessary adjustment *cannot* be made, the converter age is in need of repair.

# CHAPTER 7

## SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

### Section I. SHIPMENT AND LIMITED STORAGE

#### 79. Shipment or Limited Storage

The exact procedure for shipment or limited storage depends on the material available and the conditions under which the equipment is to be shipped or stored.

#### 80. Field Repackaging Data

*a. Materials Required.* The following chart lists the estimated amount of materials required to prepare the converter for shipment:

Materials	Amount
Waterproof barrier .....	32 sq. ft.
Single-face, flexible, corrugated paper.	65 sq. ft.
Corrugated fiberboard .....	20 sq. ft.
Pressure-sensitive tape.....	28 ft.
Gummed paper tape .....	35 ft.
Flat steel strapping .....	18 ft.
Wooden shipping box.....	1 ea.

*b. Box Size.* The inner dimensions of the shipping box required for the converter are given below:

Box No.	Height (in.)	Width (in.)	Depth (in.)	Board (ft)	Volume (cu ft)	Packed weight (lb)
1 of 1	23	19 3/4	19	34	7.2	177

*c. Packaging.* Package Single Sideband Converter CV-157/URR as follows:

- (1) *Manuals.* Package each manual within a close-fitting bag, fabricated of water-proof barrier material. Seal all seams and closures with water-resistant, pressure-sensitive tape.

- (2) *Spare parts and accessories.* Cushion spare parts and accessories individually by wrapping in flexible single-face corrugated paper. Secure cushioning with gummed paper tape. Consolidate the cushioned items together by wrapping within two thicknesses of flexible corrugated paper. Secure wrapping with gummed paper tape.
- (3) *Converter.* Cushion the converter on all surfaces with pads, fabricated of corrugated fiberboard, designed to absorb the shock of impact normally encountered in handling and transit. Wrap cushioned unit in two thicknesses of flexible corrugated paper. Secure wrapping with gummed paper tape.

*d. Field Repacking, Strapping, and Marking.*

- (1) *Repacking.* Place the converter together with the consolidated package, containing spare parts and accessories, within a nailed wooden box. Place the packaged technical literature between the packaged equipment and the lid of the shipping container. Fit the box with a sealed waterproof liner. Fabricate the box to fit the contents snugly.
- (2) *Strapping.* Strap the shipping box for intertheater shipment only.
- (3) *Marking.* Mark the shipping box in accordance with the requirements of section II, SR 55-720-1, Transportation and Travel, Preparation for Overseas Movement of units (POM).

## Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

### 81. General

The demolition procedures outlined in paragraph 82 will be used to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished upon the order of the commander.

### 82. Methods of Destruction

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

*b. Cut.* Cut cables and wiring, use axes, hand-axes, or machetes

*c. Burn.* Burn cables, resistors, capacitors coils, wiring, and manuals; use gasoline, kerosene, oil, flame-throwers, or incendiary grenades.

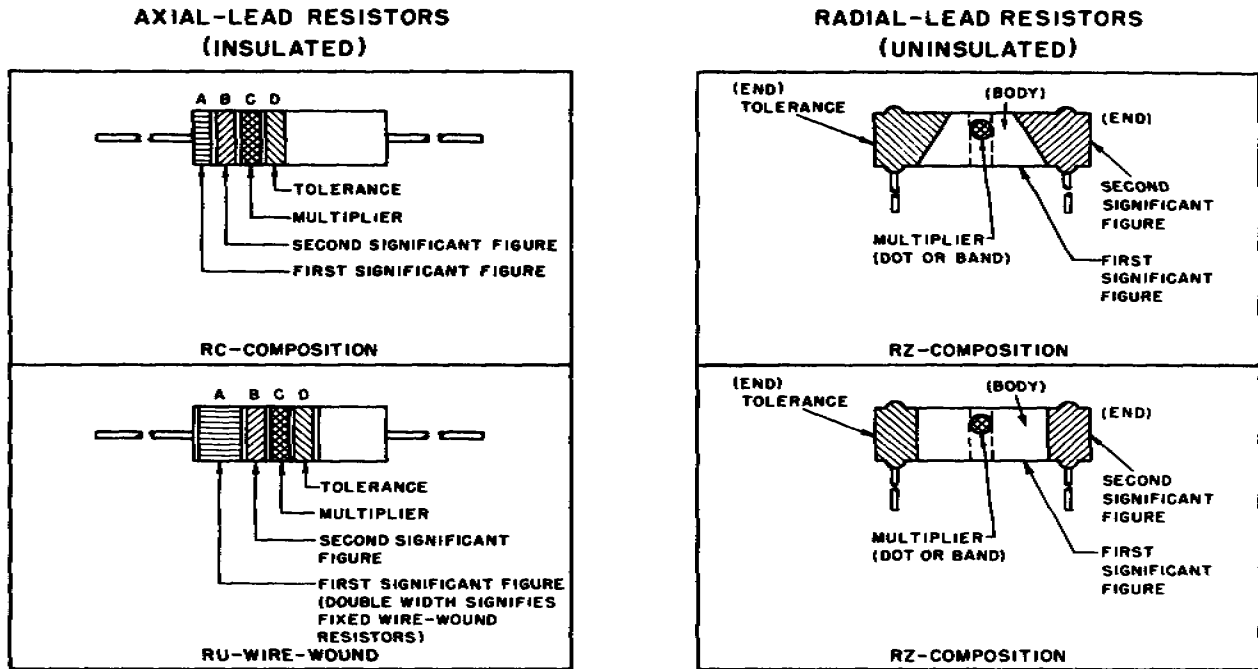
*d. Bend.* Bend panels, cabinet, and chassis.

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

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

*g. Destroy.* Destroy everything.

# RESISTOR COLOR CODE MARKING (MIL-STD RESISTORS)



## RESISTOR COLOR CODE

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

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

### EXAMPLES (BAND MARKING):

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

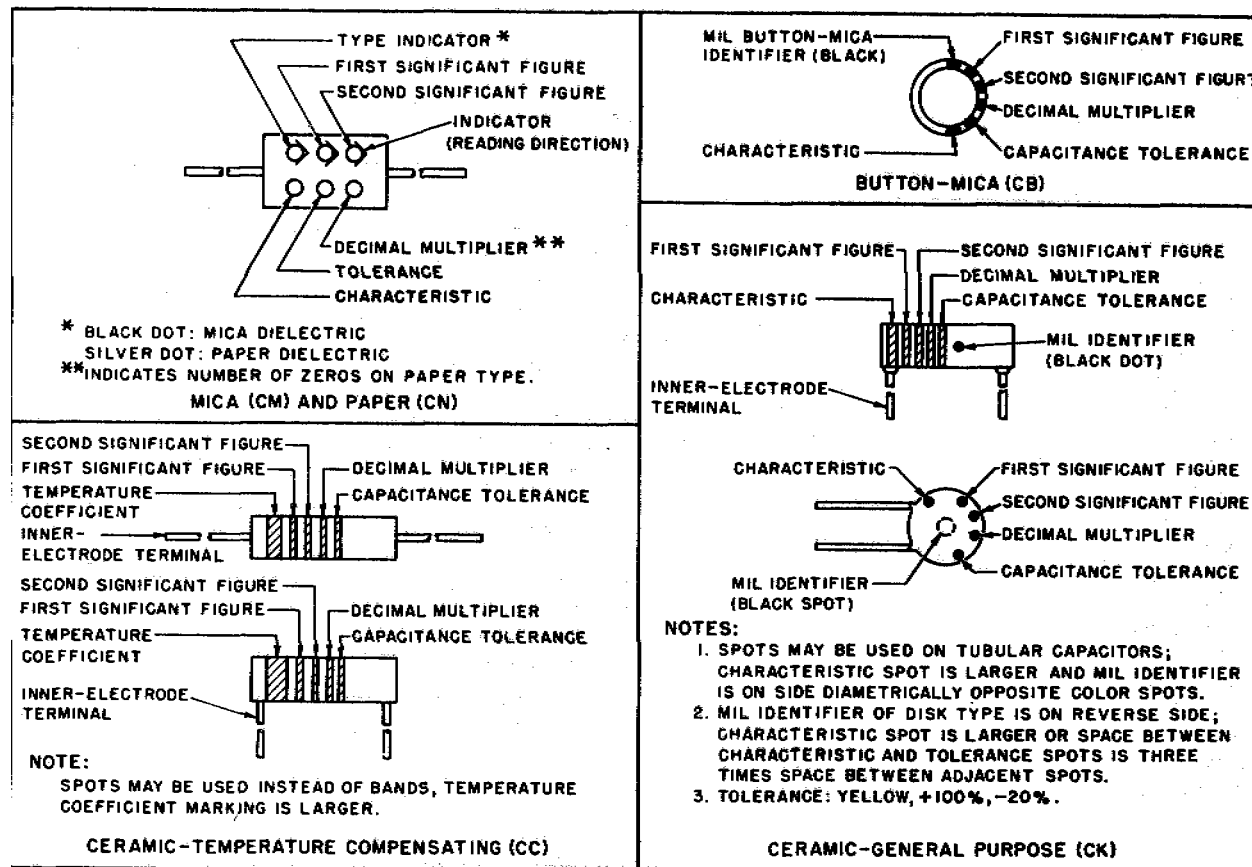
### EXAMPLES (BODY MARKING):

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

STD-RI

Figure 62. MIL-STD resistor color codes.

## CAPACITOR COLOR CODE MARKING (MIL-STD CAPACITORS)



## CAPACITOR COLOR CODE

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

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

STD-CI

Figure 63. MIL-STD capacitor color codes.

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

USAR: None.

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











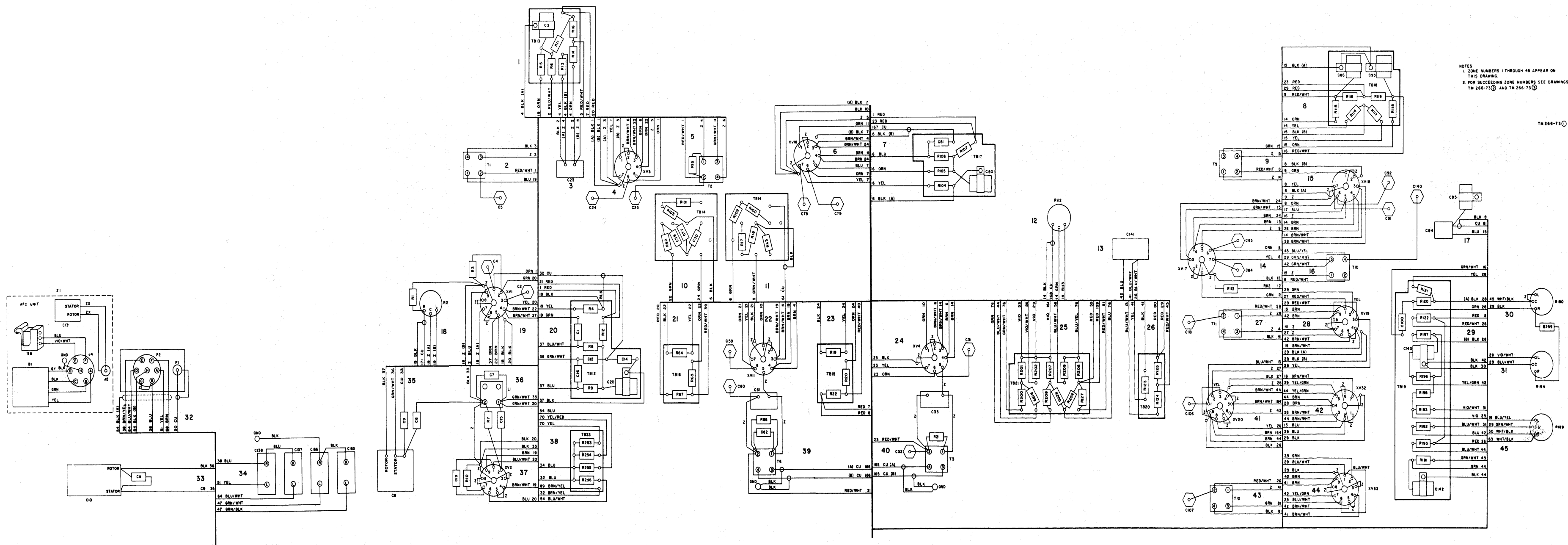


Figure 68. Converter, wiring diagram.

Figure 68. Converter, wiring diagram.

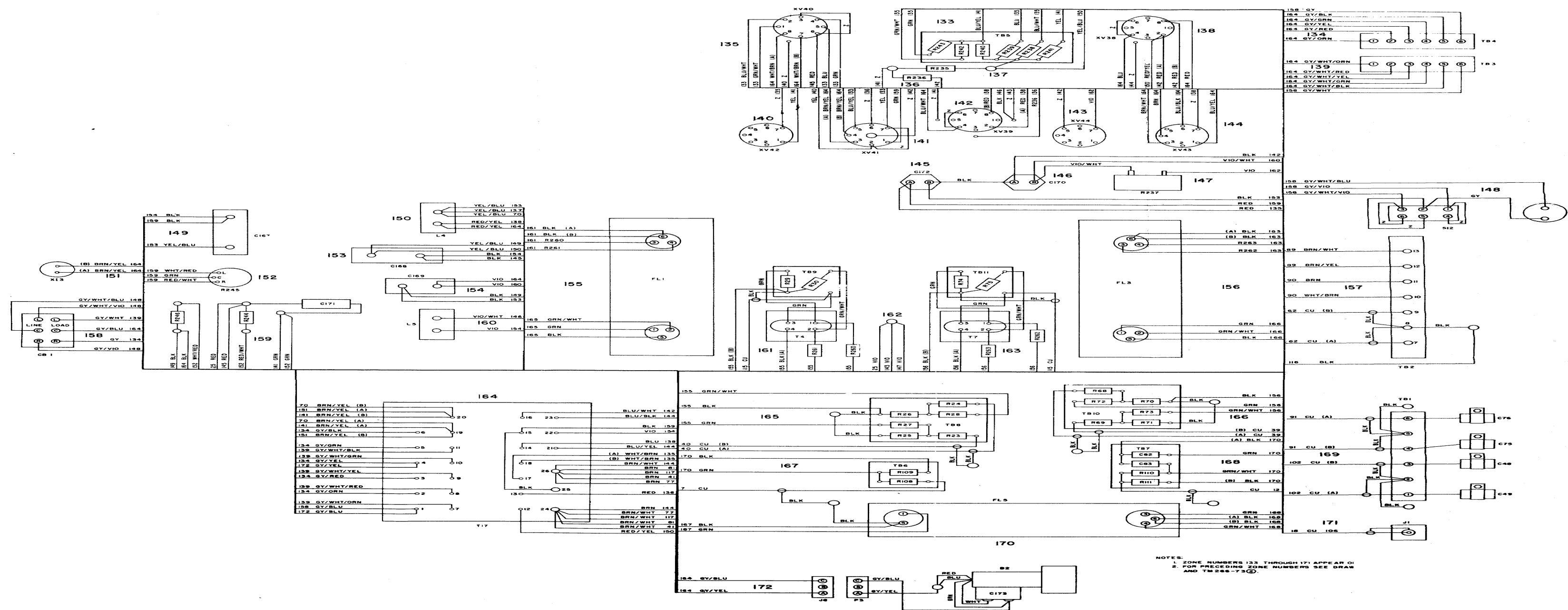
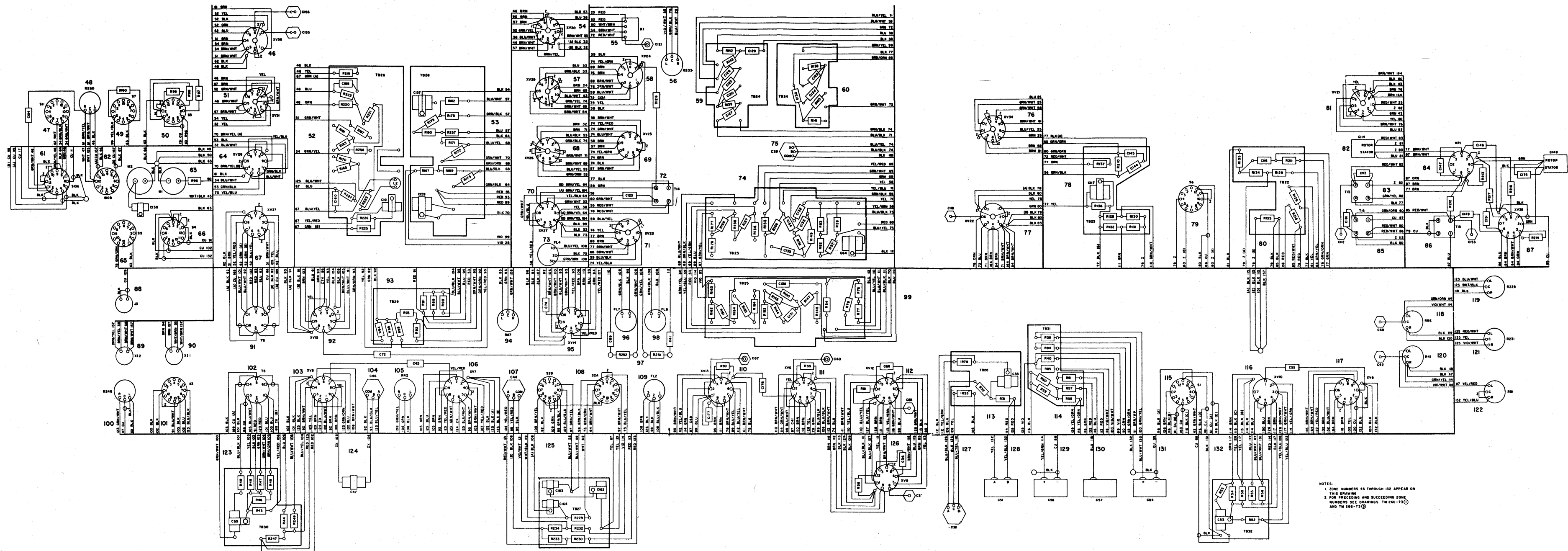


Figure 68. - Continued.





NOTES:  
 1. ZONE NUMBERS 46 THROUGH 132 APPEAR ON  
 THIS DRAWING.  
 2. FOR PRECEDING AND SUCCEEDING ZONE  
 NUMBERS SEE DRAWINGS TM 266-73 (1)  
 AND TM 266-73 (2).

Figure 68. - Continued.

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