b. Absence of AVC will cause:

- severe overloading on strong signals.

- erroneous voltage readings at V1, V2, and V3.

c. To check the AVC action:

- Connect test equipment as indicated in section 4.2.1. See Figure 2.

- Connect a VTVM to the diode load, junction of terminal 2 of T2.

- Increase the output of the RF signal generator from 1 microvolt to .1 volt.

- The AVC voltage measured on the VTVM should go more negative as the signal is increased (see tables of typical voltage readings, Section V).

- If the AVC voltage does not change, check the AVC detector, D1, and its associated network.

4.2.4 SQUELCH

a. To check the squelch section:

- Connect test equipment as indicated in 4.2.1.

- Remove the RF input.

- Turn the VOLUME control full clockwise.

- Turn SQUELCH control clockwise just enough to quiet the audio (usually between 9 and 11 o'clock).

- Reconnect the RF input.

- Feed a 1 μV, 30% modulated at 1000 Hz signal into the 6 dB pad connected to the receiver input. Squelch should open and allow audio output.

- Turn the SQUELCH control full clockwise.

- Increase signal input to 2000 μV. Squelch should open.

b. If the voltage at R31 does not vary, check for an open D1 by bridging it with a new diode.

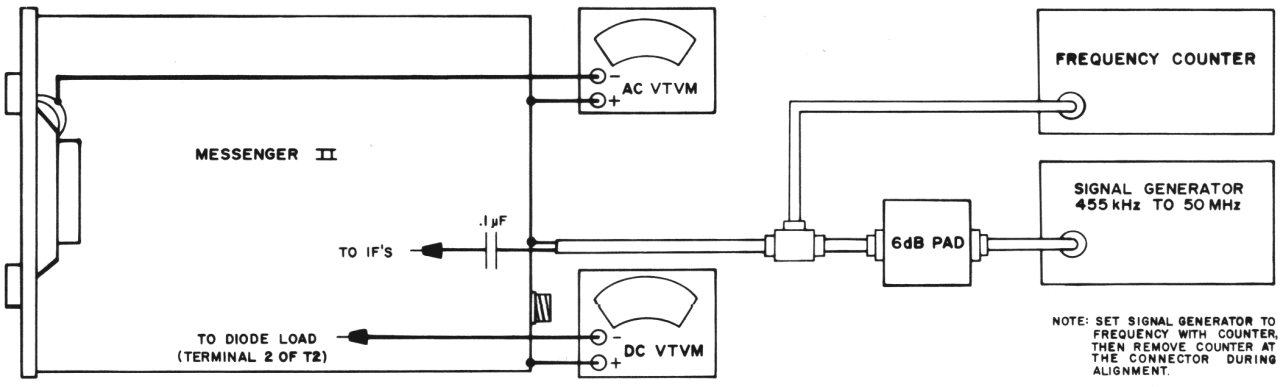
c. If the diode is not open, disconnect one end and check for a short with an ohmmeter. A normal diode will have a front-to-back ratio of approximately 10:1.

4.2.5 AUDIO

a. Connect test equipment as indicated in 4.2.1.

b. Connect an audio generator through a .1 μF capacitor to the top of the VOLUME control.

c. Set the audio generator for an output of .0025 volts RMS ±10% at 1000 Hz.



RECEIVER ALIGNMENT AND
TEST EQUIPMENT CONNECTIONS
FIGURE 2

d. Adjust the VOLUME control for 2.5 VAC (+10 dB) indicated on the AC-VTVM and turn the SQUELCH to minimum (ccw). Monitor the oscilloscope for undistorted output.

e. If output is distorted or weak, check V10 and V5 voltages. Replace with known good tubes if suspect.

4.2.6 IF STAGES

a. To check the IF stages, connect the DC-VTVM to the diode load (terminal 2 of T2). Inject RF signals with the signal generator at the points listed in the typical RF and IF level chart; the approximate input levels necessary to obtain 1 VDC output at given test points are listed. When replacing defective components, refer to the receiver alignment chart for their proper adjustment.

4.2.7 RF AMPLIFIER - 1st MIXER

a. Connect test equipment as indicated in Section 4.2.1.

b. Set the RF signal generator at 27.105 MHz, 1 microvolt 30% modulated with 1000 Hz.

c. With the VOLUME control at maximum, the output across the speaker terminals measured on the AC-VTVM should be at least 2.0 volts (1.3 watts).

d. If the receiver output is not normal, check the oscillator and mixer, V2, and its associated circuitry.

e. If it is necessary to replace components in this stage, realign the stage as outlined in the Receiver Alignment Chart.

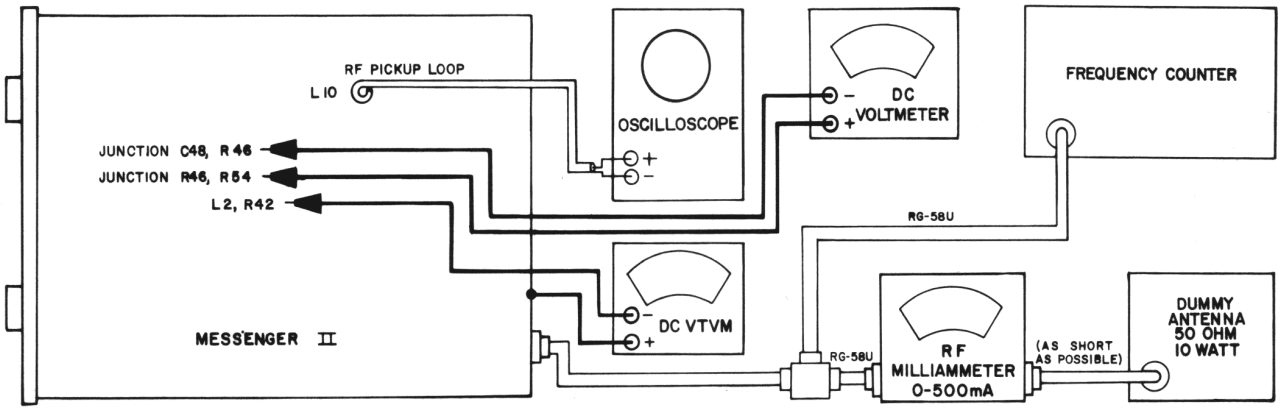
4.3 TRANSMITTER TROUBLE SHOOTING

4.3.1 TEST EQUIPMENT CONNECTIONS

a. Connect the test equipment as shown in Figure 3. Be sure to connect the 50 ohm antenna.

b. Connect DC-VTVM to junction of L2 and R42 (see Bottom View, Messenger Two).

c. Connect DC voltmeter across R46, the 100 ohm meter shunt, with the positive terminal at the junction of R46 and R54. Each volt read will represent 10 mA PA plate current.
CAUTION: Meter is floating at supply voltage above ground. Metal cases of some VTVM's may be "hot" with DC.



TRANSMITTER ALIGNMENT AND TEST EQUIPMENT CONNECTIONS
FIGURE 3

4.3.2 PRELIMINARY TRANSMITTER TEST

a. Turn power on and key transmitter.

b. Power output should be approximately 2.8 watts.

c. Set the audio generator for 1000 Hz. While monitoring the oscilloscope, increase the audio generator output level to obtain 50% modulation.

d. The modulated waveform should be symmetrical and relatively undistorted. See waveform illustrations, Figure 5.

e. The threshold of clipping should occur at approximately 75% modulation.

If the above conditions are not met, proceed with the transmitter trouble shooting procedure.

4.3.3 OSCILLATOR TROUBLE SHOOTING

a. A defective or mis-aligned oscillator stage can result in:

- loss of transmitter output
- intermittent operation
- off-frequency operation

b. To check the oscillator stage:

- key the transmitter and check for oscillator starting. If the oscillator does not start, check the voltage on V7 and replace defective components as necessary.

4.3.4 POWER AMPLIFIER TROUBLE SHOOTING

a. A defective or mis-aligned power amplifier can result in:
- reduced power output
- excessive current drain with reduced power
- distorted modulation

b. Check V8. Replace defective components as necessary and refer to the transmitter alignment chart for adjustments.

4.4 MAINTENANCE

4.4.1 CHASSIS REMOVAL

Disconnect the power cord, microphone cable, antenna cable and Tone-Alert cord or jumper plug. Stand the unit on its front panel on a flat surface. Remove the six #8 sheet metal screws fastening the cabinet to the rear of the chassis. Carefully slide the cabinet up and off the chassis.

4.4.2 CHANGING CRYSTALS

To add or change operating channels, remove the chassis from the cabinet. Locate the transmit crystal sockets and receive crystal sockets. A clear plastic plate located above the crystal sockets indicates function and channel switch position of each socket. After determining the proper socket for the crystals you are installing, remove the clear plastic plate and insert the crystals. Transmit crystals are indicated by a T followed by the channel number; receive crystals by an R followed by the channel number. Replace the clear plastic plate and replace the cabinet in the chassis.

4.4.3 REPLACING INDICATOR LIGHTS

The "transmit" and "on" indicator lights are long life neon types, soldered by their leads to terminal strips located on top of the chassis. To replace these lights, remove the Messenger chassis from its cabinet and unsolder the light leads from the terminal strip. The lights will slide out of their sockets easily. Insert the new lights carefully, to prevent their "snapping in" to the sockets and breaking.

SECTION V
TYPICAL READINGS

5.1 TYPICAL RESISTANCES AT CONNECTORS

- All measurements to ground.

5.1.1 J3, 9 pin power socket, with plug disconnected.

Pin	Resistance-ohms
1	103
2	0
3	Infinite
4	Infinite
5	Infinite
6	Infinite
7	0.9
8	1.1
9	0
Between pins 3 and 4	4.3
Between pins 1 and 7	103

5.1.2 J5, antenna socket, with antenna disconnected.

Center pin	47,000
Body	0

5.1.3 J10, 12 pin Tone-Alert socket - plug disconnected.

Pin	Resistance-ohms
1	Infinite
2	Continuity to pin 8 on J11
3	1 meg
4	1.7 meg
5	Infinite
6	0
7	570,000
8	Infinite
9	200,000
10	Infinite
11	0.2
12	2,800

5.2 TYPICAL WINDING RESISTANCES

5.2.1 T4, output and modulation transformer.

	Resistance-ohms
Blue to red	206
Brown to yellow	164
Green to black	0.36

5.2.2 T5, 13.6 VDC and 117 VAC vibrator transformer.

Black to black	4.3
Gray to brown (entire primary)	0.45
Brown to brown	0.31
Brown to yellow	0.15
Red to Red	295
Red-yellow	
Red-yellow to red	151 & 144

5.2.3 VIB-1, Vibrator

(6 volt) pin 1 to pin 4	10
(12 volt) pin 1 to pin 4	43

5.2.4 LS1, Speaker

Voice coil	2.7

5.2.5 L12, Audio Inductor

Black to black	185

5.3 TYPICAL AUDIO LEVELS IN RECEIVER

Volume control full clockwise.
Squelch control counterclockwise.
Measured to chassis with AC-VTVM.
0.4 Volts RMS, 455 kHz, 30% modulated at 400 Hz applied to T2, Terminal 5.

Test Point	Volts RMS
Diode Load, T2 Terminal 2	0.15
Top of Vol. control, R21 Term. 3	0.0135
V10A grid, pin 7	0.012
V10A plate, pin 6	0.12
V10B plate, pin 1	0.12
V5B grid, pin 2	0.11
V5B plate, pin 3	4.7
V6 grid, pin 3	4.2
V6 plate, pin 9	148
T4, modulator secondary, yellow	140
T4, output secondary, green	2.5

5.4 TYPICAL RF AND IF LEVELS IN RECEIVER

Reference: 1 volt DC at diode load (terminal 2 of T2), measured with DC-VTVM. Input levels are given at the input to a 6 dB 51.5 ohm pad

TEST POINT	FUNCTION	INPUT FREQUENCY	INPUT LEVEL
T2, pin 5	Det. Diode	455 kHz	0.75 volt
V4 plate, pin 5	IF AMP	455 kHz	2.35 volts
V4 grid, pin 1	IF AMP	455 kHz	21,500 microvolts
V3 plate, pin 5	IF AMP	455 kHz	180,000 microvolts
V3 grid, pin 1	IF AMP	455 kHz	2,900 microvolts
V2 plate, pin 5	MIXER	455 kHz	3,100 microvolts
V2 signal grid, pin 7	MIXER	455 kHz	3,000 microvolts
V2 signal grid, pin 7	MIXER	27.105 MHz	230 microvolts
V2 osc. grid, pin 1	MIXER	455 kHz	*76 microvolts
V1 plate, pin 5	RF AMP	27.105 MHz	140 microvolts
V1 grid, pin 1	RF AMP	27.105 MHz	8.0 microvolts
Antenna socket		27.105 MHz	0.9 microvolts

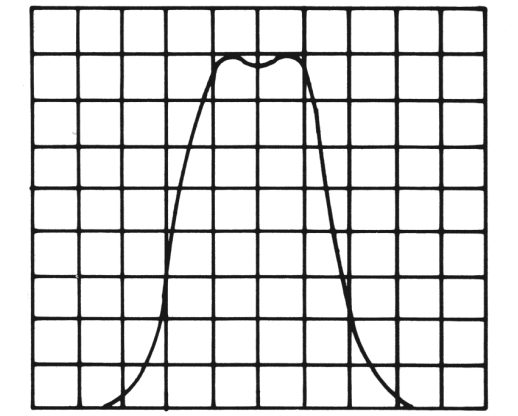
*Crystal will not oscillate when signal generator is connected to oscillator grid.

NOTE: TYPICAL VALUES MAY VARY ±20%

5.5 TYPICAL AVC CHARACTERISTICS

Volume control advanced for reference of .0245 VRMS at voice coil.
Signal Generator: Hewlett-Packard 606A with 6 dB 51.5 ohm pad.
27.105 MHz, 30% modulation at 400 Hz.
Audio measured with AC-VTVM across voice coil.

RF INPUT TO PAD MICROVOLTS	AUDIO OUTPUT dB	AVC LINE TERM. 2, T2 VOLTS
0.316	-11.5	- 0.32
1	0 *	- 1.15
3.16	+ 8.0	- 2.25
10	+13.0	- 3.4
31.6	+16.75	- 4.7
100	+18.5	- 6.1
316	+21.0	- 7.6
1K	+23.0	- 9.4



TYPICAL IF TRACE
FIGURE 4

TYPICAL READINGS (cont'd)

RF INPUT TO PAD MICROVOLTS	AUDIO OUTPUT dB	AVC LINE TERM. 2, T2 VOLTS
3.16K	+25.5	-11.8
10K	+28.5	-14.7
31.6K	+32.5	-19.1
100K	+35.5	-25.0

* Reference .0245V RMS

Input to open tight squelch: Typical 100 to 500 microvolts.

5.6 TYPICAL AUDIO LEVELS IN TRANSMITTER

Audio measured with AC-VTVM.

Modulation measured with oscilloscope at RF output.
PA plate current 24 mA.
Modulating frequency 1,000 Hz.

	Reference 50% Modulation	Reference 80% Modulation*
Microphone input	0.011 Volt	0.020 Volt
V10B pin 2 Grid	0.011	0.020
V10B pin 1 Plate	0.11	0.20
V10A pin 6 Plate	0.05	0.14

* Threshold of limiting.

SECTION VI
ALIGNMENT

6.1 RECEIVER ALIGNMENT CHART

ALIGNMENT	CONNECTIONS AND SETTINGS	ADJUSTMENTS
455 kHz IF (with IF transformers completely out of alignment).	Connect test equipment as in section 4.2.1 except connect RF signal generator through .1 μF capacitor to pin 1, XV4. (See Figure 3). Connect DC-VTVM to diode load - terminal 2 of T2. Set signal generator at 455 kHz ±.01% modulated 30% at 400 Hz.	Adjust R83 for maximum IF gain (full clockwise looking at top of chassis). Preset top core of T2, T7, T6, T1 flush with top of can. Adjust bottom core of T2 for maximum audio output. Adjust top core of T2 for maximum audio output. DO NOT readjust the bottom or top core. NOTE: Reduce input and volume as necessary on this adjustment. Make final adjustment at each core with input reduced to give approximately 1.5 volts at diode load.
	RF signal generator to pin 1, XV3.	Adjust top, then bottom core of T7 as above, then T6.
	RF signal generator to pin 1, XV2.	Adjust top, then bottom core of T1.
455 kHz IF (with IF transformers approximately in alignment).	Connect test equipment as per above alignment except signal generator to pin 1, XV2.	Adjust transformers in order, T2, T7, T6 and T1 bottom, then top cores.
Visual Presentation of IF Selectivity Curve (Optional)	Use a very stable 455 kHz sweep generator with a narrow sweep - about 25 kHz.	Adjust bottom core of T1 to shape low frequency side of trace.

ALIGNMENT	CONNECTIONS AND SETTINGS	ADJUSTMENTS
	Use an oscilloscope having a linear sweep and good stability. Replace signal generator used in 4.2.1 with sweep generator at pin 1, XV2. Connect 'scope vertical input junction of R17 and D2. Connect sweep generator sawtooth sweep output to sweep input of 'scope. Connect a 1 μF or larger paper capacitor across the AVC line to chassis - from the end of R2 on TS6 to chassis is convenient.	Adjust top core of T2 to shape high frequency side of trace. See Figure 5 for typical IF trace.
Crystal oscillator	Same as section 4.2.1.	Zero beat (±100 Hz) the Messenger Two crystal oscillator against the frequency meter at 26.650 MHz (channel 12 - receive) by adjusting the core in L3.
RF Stages	Connect signal generator through 6 dB 50 ohm pad to antenna jack. Calibrate with frequency counter. Remove counter before alignment. Connect AC-VTVM across the speaker voice coil (green lead to chassis). Set channel switch to channel 1. Set signal generator to 26.965 MHz (channel 1), modulated 30% at 400 Hz or 1000 Hz. Keep signal generator output low on this and following adjustments	Tune top core of T3 from the core out position inward to the second peak, tuning for maximum audio output. The second peak is stronger than the first peak. The core will be approximately 9/16 inch from the top of the can when tuned to the second peak. During this and following adjustments, keep signal generator output low so that AVC voltage does not exceed 2 volts.
	Set channel switch to channel 22. Set signal generator to 27.225 MHz (channel 22), modulated as above.	Tune the bottom core of T3 from the core out position, tuning for maximum audio output. Tune from the core out position to avoid tuning to the crystal oscillator or image frequencies which are lower in frequency than the signal frequencies.
Antenna	Repeat above RF alignment steps.	Repeat above RF alignment steps.
	Set channel switch to channel 12. Set signal generator to 27.105 MHz (channel 2), modulated as above.	Tune the core of L1 from the core out position for maximum audio output.
	Adjust antenna input to 1 micorvolt at the input to the 6 dB 50 ohm pad.	Measure AVC voltage at the diode load. (Typical 1.0 to 1.7 volts.) If it exceeds 1.5 volts adjust R83 to give 1.5 volts.

ALIGNMENT	CONNECTIONS AND SETTINGS	ADJUSTMENTS
VFO (late models)	C111 (front panel tuning capacitor) indicator dot centered in front panel bezel. Connect crystal-controlled signal generator to antenna jack. Set crystal-VFO slide switch, SW4, to VFO position. Set rotor plates of C110, bracket mounted trimmer capacitor, at about 1/3 mesh by positioning the corners of the rotor plates opposite the "notch" in the stator plates.	C111 plates should be at full mesh.
	Set channel indicator and signal generator to channel 1.	Adjust core in L113 for maximum audio signal. NOTE: Core is brass and will decrease the inductance of the coil, increasing oscillator frequency, as it is inserted.
	Set signal generator to channel 18.	Dial indicator should read about 19 1/2 for maximum audio output with cabinet removed.
	Secure core in L113 with coil dope placed between core and coil form. After cabinet is replaced and Messenger Two has been allowed to warm up for 20 minutes, set dial indicator and signal generator to channel 18.	Adjust trimmer C110 for maximum audio signal. A hole in the rear panel allows screwdriver adjustment of C110.
Antenna	Connect DC-VTVM at diode load (terminal 2 of T2).	Adjust antenna input to 1 microvolt at the input to the 6 dB 50 ohm pad and measure AVC voltage at the diode load. (Typical 1.0 - 1.7 volts). If it exceeds 1.5 volts, adjust R83 to give 1.5 volts.

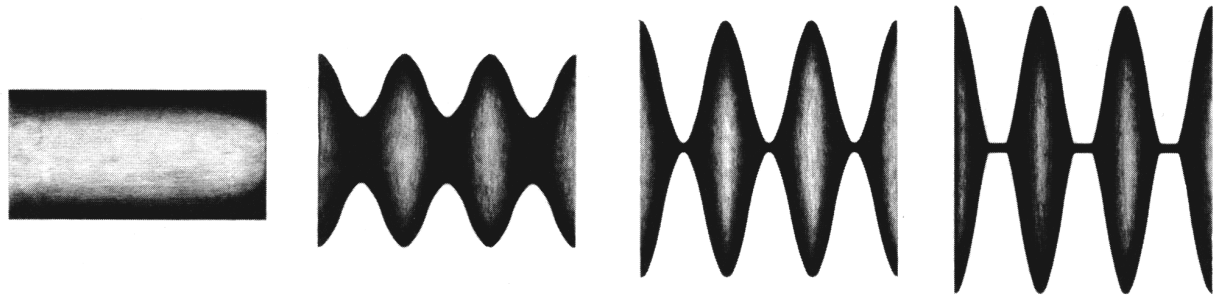
6.2 TRANSMITTER ALIGNMENT CHART

ALIGNMENT	CONNECTIONS AND SETTINGS	ADJUSTMENTS
Preliminary Crystal Oscillator Adjustment	50 ohm resistive dummy antenna with 0-500 mA RF milliameter connected to antenna jack. DC-VTVM connected to junction of L2, R42 (see bottom view, Figure 8). Connect frequency counter in parallel with RF ammeter (see Figure 3). Key transmitter.	Zero beat approximately the transmitter oscillator against the frequency meter by adjusting L5. This will be precisely adjusted after the power amplifier is adjusted. Adjust L7 for maximum grid voltage.

ALIGNMENT (cont'd)

ALIGNMENT	CONNECTIONS AND SETTINGS	ADJUSTMENTS
Preliminary Power Amplifier Adjustments	As above except disconnect frequency counter.	Adjust Pi-L network for maximum RF current to dummy antenna while maintaining 24 mA plate current or a lesser value, whichever gives greatest output. Adjust C49 for desired PA plate current at dip. Last adjustment must be L9 for dip in PA plate current.
Power Amplifier Neutralization (normally requires checking only when V8 is replaced)	As above, Preliminary PA adjustments.	Note rectified DC grid voltage on PA as L9 is tuned through resonance. If PA grid voltage increases in magnitude when core of L9 is backed out of coil, value of C44 is too low. Increase C44 capacity gradually (one-half turn clockwise at a time) and repeat test above. If PA grid voltage increases in magnitude when core of L9 is turned into the coil, value of C44 is too high. Decrease C44 capacity one-half (counter-clockwise) turn at a time and repeat test above. At the correct setting, grid voltage will rise equally -- but only slightly or not at all -- on each side of resonance.
Final Power Amplifier Adjustment	As above, Preliminary PA adjustments.	Re-adjust PA tuning and coupling as in Preliminary Power Amplifier Adjustment above, but make last adjustment detuning L9 slightly counter-clockwise (core out) for maximum RF output while keeping PA plate current at desired value. RF line current: 230 mA typical 210 mA minimum
Final Crystal Oscillator Adjustment:		
Plate	DC-VTVM to junction of L2 and R42.	Adjust L7 for maximum rectified grid voltage on the Power Amplifier. Minimum: -13 volts. Typical: -18 volts.
Grid	As above. Preliminary crystal oscillator alignment, modulation off.	Zero beat (±10 Hz) the transmitter crystal oscillator against the frequency meter by adjusting L5.

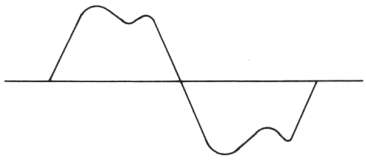
ALIGNMENT	CONNECTIONS AND SETTINGS	ADJUSTMENTS
Modulation check	Audio oscillator to pin 2 of microphone connector. Connect 50 ohm dummy antenna and RF milliameter. Lightly couple RF output directly to vertical plates of oscilloscope (not through scope amplifier). See Figure 6. Place loop near L10. Do not couple to L9. Disconnect audio oscillator.	Observe output waveform. Threshold of limiting will occur at about 80% modulation. RF line current will increase about 15-20% with modulation. With voice, approximately 100% modulation will occur on negative peaks. See typical transmitter waveforms, Figure 5, and clipped audio waveform, Figure 7.



UNMODULATED CARRIER | 50% MODULATION | 100% MODULATION | OVER 100% MODULATION

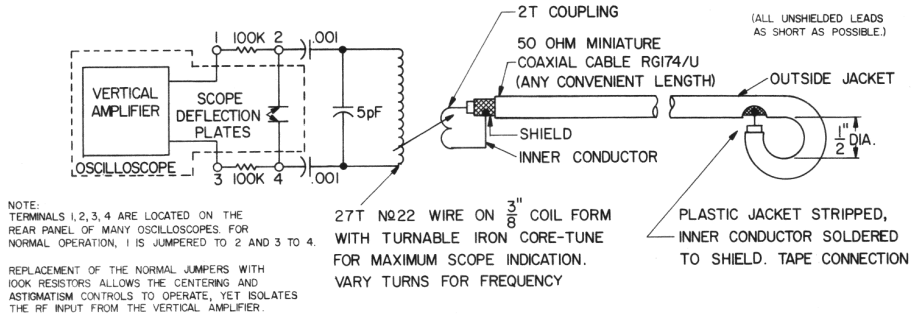
TRANSMITTER WAVEFORMS
FIGURE 5

NOTE: Figure 5 shows output waveforms. Intentional audio peak clipping (see Figure 7) limits the crests and valleys to about 90% modulation with sine wave input. With voice modulation, the valleys are modulated to approximately 100%.



CLIPPED AUDIO WAVEFORM

FIGURE 7



OSCILLOSCOPE RF PICK-UP LOOP
AND METHOD OF CONNECTION
FIGURE 6