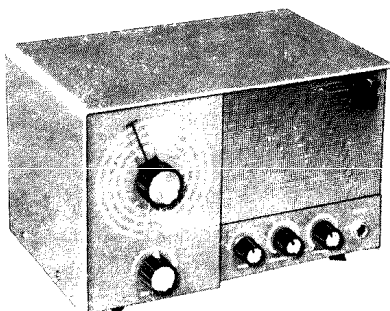


# Assembly and Operation of the



## ECONOMY SWL RADIO MODEL GR-81



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HEATH COMPANY,  
BENTON HARBOR,  
MICHIGAN



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## SPECIFICATIONS

Frequency Coverage -	
Band A. . . . .	140 to 560 kilocycles.
Band B. . . . .	560 to 1730 kilocycles.
Band C. . . . .	1.73 to 5.5 megacycles.
Band D. . . . .	5.5 to 18 megacycles.
Audio Output. . . . .	1 watt to speaker (PHONES jack for headphones or external speaker).
Controls. . . . .	Main Tuning. FINE TUNING. BAND. REGENERATION. OFF/VOLUME.
Tube Complement. . . . .	12AT7 detector/audio amplifier. 50C5 audio output amplifier. 35W4 rectifier.
Antenna Inputs. . . . .	LONG and SHORT ANTENNA, GROUND.
Power Requirements. . . . .	117 V AC, 50/60 cps only, 30 watts.
Dimensions. . . . .	10" wide x 7" high x 7" deep.
Net Weight. . . . .	9-3/4 lbs.
Shipping Weight. . . . .	11-1/2 lbs.

## INTRODUCTION

The Model GR-81 SWL (Short Wave Listener) Radio has been designed to provide a large scope of listening excitement from stations of many parts of the world. The four bands of frequencies that are covered will allow reception of the 160, 80, 40, and 20 meter amateur bands, marine signals, aircraft signals, distress frequencies, standard broadcasts, government stations, international broadcasts, etc. The Main

Tuning and FINE TUNING knobs make tuning simple. There are provisions for a short or a long antenna to cope with reception characteristics in various localities, depending on signal frequencies and strengths. The circuit of the Radio incorporates a filter choke in the power supply for a low hum level and a power isolation transformer to eliminate shock hazards. Normally common to series string, AC-DC circuits.

## RADIO

Radio is a means of sending information through space from one point to another, without wires connecting the two points. The different forms of information transmitted are many and varied, but are frequently either sound waves produced by a voice or an orchestra, or a wave so interrupted that it is broken into a combination of long and short groups that correspond to the characters of the Morse code.

When an announcer speaks into a microphone in a radio broadcast station, the sound waves created by his voice are picked up by the microphone and changed into electrical impulses. The weak electrical impulses from the microphone are then fed into a transmitter. The transmitter amplifies or strengthens the weak signals from the microphone and transforms them into an electrical form that can be fed to an antenna and radiated

through space. Similarly, when the amateur radio operator talks into a microphone, the weak electrical impulses from the microphone are fed into a transmitter, antenna system, and radiated in much the same fashion as for standard broadcast stations.

When these electrical signals leave the transmitting antenna, they are called radio waves. They may spread out in all directions, or they may be beamed in one direction, depending on the type of transmitting antenna used.

A receiving antenna picks up a small part of these radio waves and feeds it into the receiver in the form of an electrical signal. For a receiver to be used effectively, it must separate the desired station from the many others. This is accomplished with one or more tuned circuits

which select one station and reject most others. The radio wave is then fed to a detector.

In the case of broadcast stations, the detector separates the audio frequency signal from the electrical signal that came from the transmitter; therefore the output of the detector is an audio signal. This is where the announcer's voice, or the orchestra, is restored to its original form.

This signal is often very weak, requiring that it be amplified to a point where it is strong enough to operate a headphone or loudspeaker.

The output of the detector is fed to an audio amplifier which increases the strength of the signal so it can operate headphones or a loudspeaker. These devices convert the electrical signal back into sound waves that can be heard.

## CIRCUIT DESCRIPTION

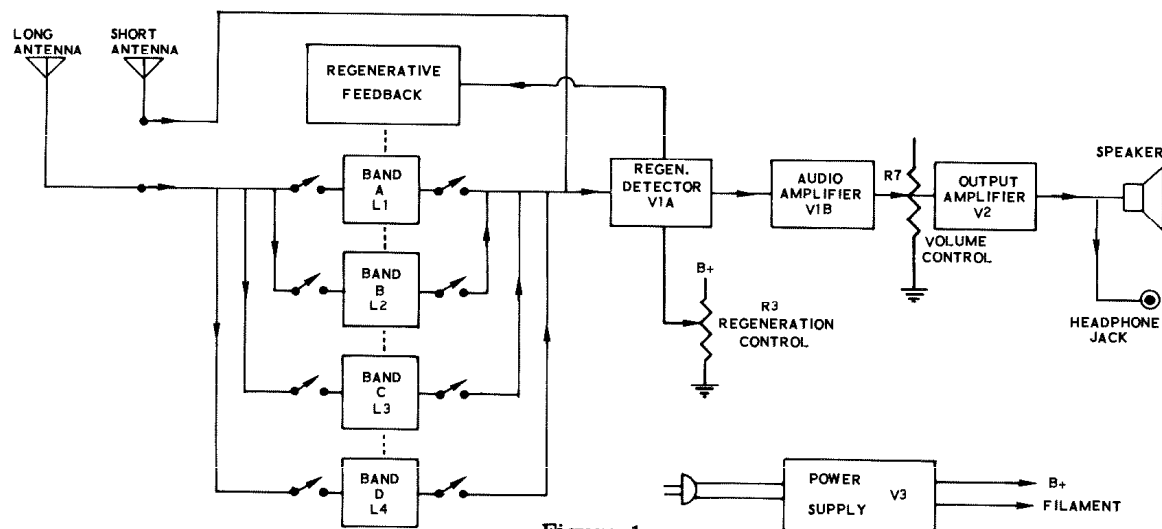


Figure 1

Refer to the Block Diagram of Figure 1 and to the Schematic Diagram on Page 9 for a better understanding of the following description.

With the antenna connected to the LONG ANTENNA input terminal (as would normally be the case with an adequate antenna), the signal received is coupled to the primary winding of one of the coils; the coil is selected by the BAND switch. The secondary and tickler windings of this same coil are connected to the grid and plate circuits, respectively, of regenerative detector stage V1A. A different coil is used on

each band; that is, L1 for band A, L2 for band B, etc. The rear section of the Main Tuning capacitor is permanently connected across the Band A coil secondary, and is used in parallel with the front section of C3 to obtain enough capacity to tune the lower frequencies on Band A.

The signal received is coupled through the coil by transformer action to the secondary winding where it is tuned with Main Tuning capacitor C3. This "selected" signal is fed to the grid circuit of V1A. Then it is amplified by tube action and appears in the plate circuit and tickler winding of



the same coil. The tickler winding is also transformer coupled to the secondary, such that a portion of the amplified signal appears back in the coil secondary to reinforce the original signal received by the antenna. This action is known as regeneration. The amount of regeneration (or re-amplification) is adjusted by controlling the gain of the tube. This is accomplished by adjusting the DC plate voltage on the tube by setting REGENERATION control R3.

When the REGENERATION control is set near its grounded end (counterclockwise), the voltage on the detector plate is very low. The result is that little regeneration takes place and the detector is quite insensitive. As this control is turned clockwise, the amount of regeneration and sensitivity increases until a point is reached where the detector goes into oscillation. This occurs when the signal fed back into the secondary winding by the action of the tube and tickler is stronger than the original signal coming from the antenna. At this point, the detector is effectively "producing its own signal." Maximum sensitivity of the detector will occur just before the point of oscillation.

The action of the regenerative detector is the same when the SHORT ANTENNA input is used and the signal is capacitively coupled directly into the grid circuit of V1A by capacitor C1.

FINE TUNING capacitor C4 (connected in parallel with the Main Tuning capacitor) has a much smaller variation in capacity over its range than does the Main Tuning capacitor. This allows much more accurate tuning of the desired signal and is quite useful at higher frequencies where stations are relatively close together.

Thus far, the "detector" has acted mainly as a very sensitive radio frequency amplifier. Actual

detection occurs because the currents in the detector plate circuit not only vary at the "carrier" radio frequency, but also vary with the intelligence placed upon the carrier at the transmitter. The much higher frequency carrier wave is removed by the filtering action of capacitor C6 and RF choke L5. For the most part, only the voice frequencies (in the case of a broadcast station) appear at the grid circuit of V1B.

V1B acts as a conventional audio amplifier that greatly increases the weak audio signal recovered by the detector. The output of V1B is capacitively coupled to VOLUME control R7. Depending on the setting of R7, all or a portion of the signal across it is fed to the grid of audio output tube V2. Tube V2 acts as a second stage of audio amplification, but is so designed to provide adequate power output to drive the output transformer and speaker.

When a headset is plugged into the PHONES jack, the headset is connected in series with the speaker, but, because the speaker has a much lower impedance than the phones (8  $\Omega$  compared to about 1000  $\Omega$ ), practically all of the sound is reproduced by the phones.

Tube V3 is a rectifier that converts alternating current to the direct current required for operation of the tubes. Capacitor sections C11B and C11C with filter choke L6 provide additional filtering of the DC for hum-free operation.

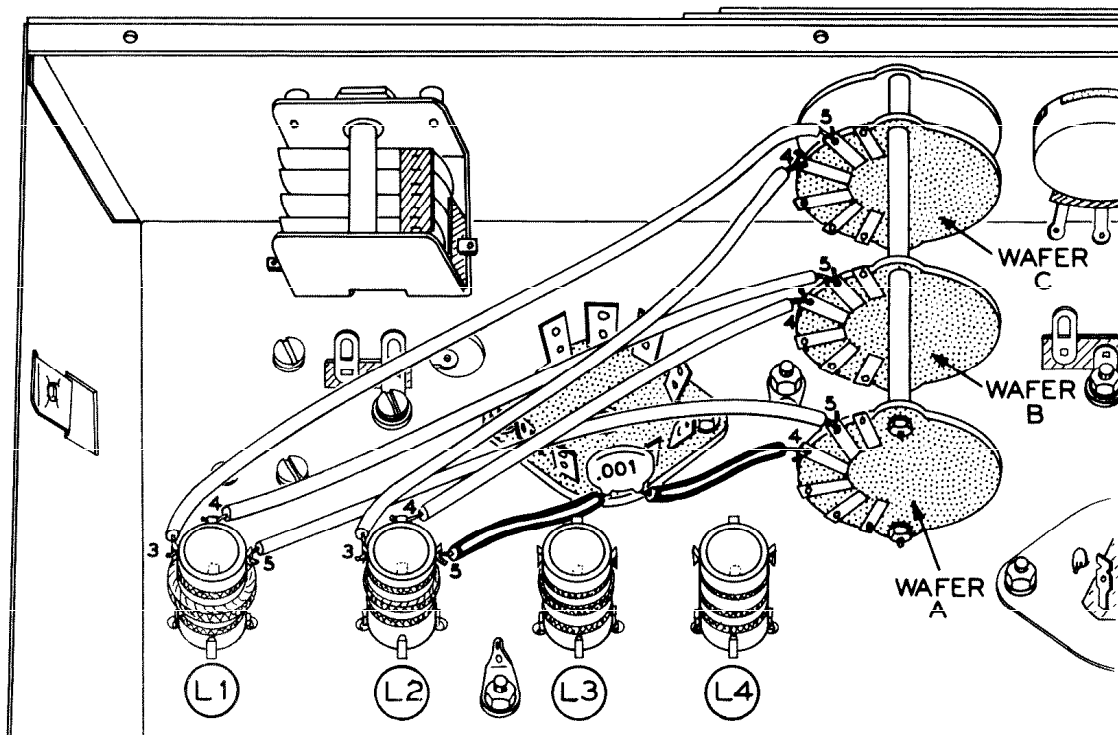
Isolation transformer T2 is used to eliminate the shock hazard common to series-string AC-DC devices; its sole purpose is to isolate the power line from the chassis and other circuitry. The fuse provides protection in the event of accidental short circuit in the power supply circuit.

## CONSTRUCTION NOTES

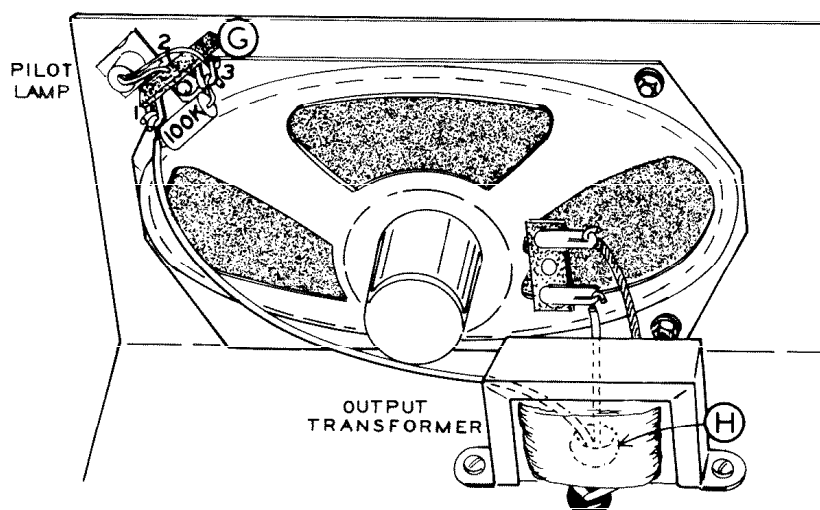
This manual is supplied to assist you in every way to complete your kit with the least possible chance for error. The arrangement shown is the result of extensive experimentation and trial. If followed carefully, the result will be a stable instrument, operating at a high degree of dependability. We suggest that you retain the manual in your files for future reference, both

in the use of the instrument and for its maintenance.

**UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST.** In so doing, you will become acquainted with the parts. Refer to the charts and other information on the inside covers of the manual to help you identify



Pictorial 6

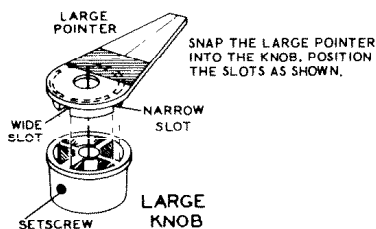


Pictorial 7

## FRONT DIAL PANEL MOUNTING

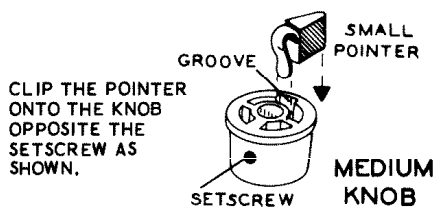
Refer to Detail 7A for the following steps.

- ( ) Install control nuts on the brass bushings of the 2-section variable capacitor and capacitor A by turning them until they touch the other control nuts. Now turn these last two control nuts counterclockwise exactly 4-1/2 revolutions.
- ( ) Mount the front dial panel to the front subpanel, using two control nuts on the brass bushings as shown. Before tightening the nuts, make certain the edges of the dial panel and subpanel line up properly with each other.
- ( ) Rotate all of the exposed shafts on the front dial panel and control plate fully counterclockwise.
- ( ) Install a 2" knob pointer on a large knob as shown in Detail 8A. Install this knob on the 2-section variable capacitor shaft. Make sure the pointer is centered over the long mark on the lower end of the frequency scales when tightening the setscrew to the shaft.



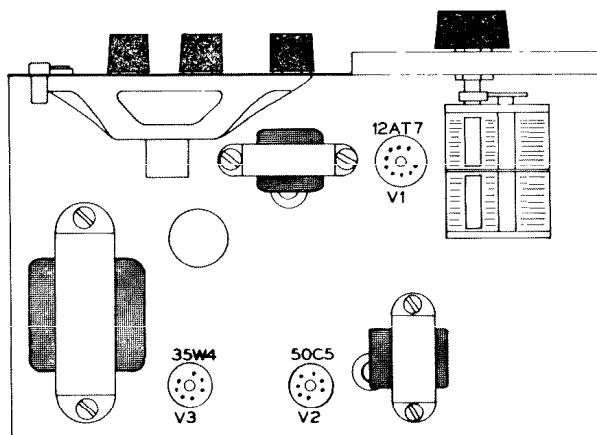
Detail 8A

- ( ) Install a snap-on knob pointer on the medium knob as shown in Detail 8B. Install this knob on the FINE TUNING capacitor shaft. Set the pointer to the first mark at the left of the knob when tightening the setscrew.



Detail 8B

- ( ) Install the three small knobs on the shafts of the BAND switch, REGENERATION control and VOLUME control. Set the inserted knob pointer to the first mark on the left of the knob before tightening the setscrew. NOTE: The setscrew of the knob on the BAND switch should be tightened to the flat side of the shaft.
- ( ) Using the edge of a sharp knife, remove the protective paper from the back of the nameplate tag and press the nameplate in position near the pilot lamp as shown in Pictorial 8.
- ( ) Install the proper tube in each tube socket indicated in Detail 7B.



Detail 7B

## INITIAL OPERATION CHECK

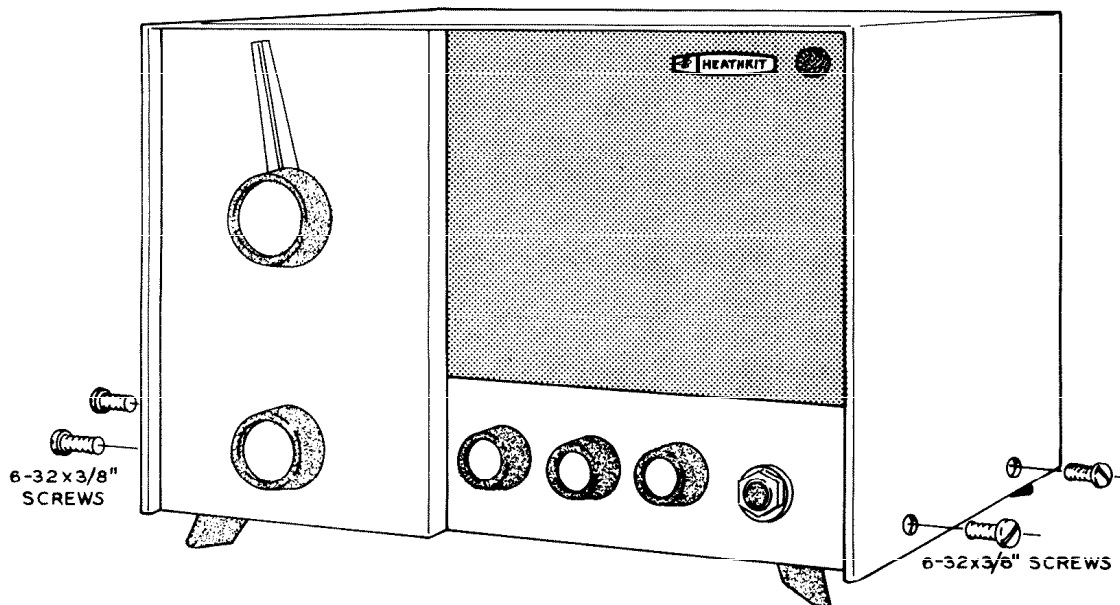
- ( ) Plug the line cord into an electrical outlet, 105 to 125 volts, 50/60 cps, AC only. Turn the Radio on by turning the VOLUME control clockwise until you feel the switch click. The tubes should glow red within a few moments after the Radio is turned on. The pilot lamp will take about 1/2 minute before it starts to glow red. If any overheating is noticed, turn off the Radio and refer to the In Case Of Difficulty section of this manual. A long warm-up time is normal.
- ( ) If the tubes and pilot lamp light up properly, turn the VOLUME control fully clockwise, the REGENERATION control about 3/4 turn clockwise and the BAND switch to B (broadcast band). There should be a background noise from the speaker.

- ( ) Put your finger on the SHORT ANTENNA terminal on the rear of the chassis. Local broadcast stations should be heard when rotating the Main Tuning knob. The stations will have a whistle present with them if the REGENERATION control is advanced too far.
- ( ) Try the other Bands (A, C and D). Some

stations, whistles, and CW (continuous wave) code signals may be heard. Band C may not have much activity during the daytime. If your Radio does not perform as indicated in the three previous steps, refer to the In Case Of Difficulty section. If operation seems normal, unplug your Radio and proceed with the following steps.

## FINAL ASSEMBLY

- ( ) Install the four plastic feet to the bottom chassis plate as shown in Detail 7A. Use 6-32 x 3/8" screws, #6 lockwashers, and 6-32 nuts as shown in Detail 7A.
  - ( ) Mount the cabinet to the chassis, using four 6-32 x 3/8" screws as shown in Pictorial 8.
- This completes the assembly of your Radio. Proceed to the following section of the manual.



Pictorial 8

## ANTENNAS

### ANTENNA AND GROUND CONNECTIONS

A suitable antenna and good ground system are a "must" for proper operation of this Radio. It is also strongly recommended that a lightning arrestor be used with the antenna for safety reasons. See Figure 2.

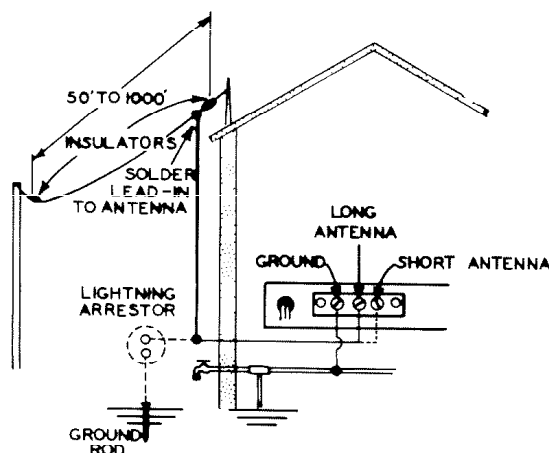


Figure 2

An adequate GROUND system consists of connecting a short length of wire from the ground terminal on the Radio to a nearby water pipe. A 6 to 8 foot ground rod driven into the earth will also work well when a good water pipe ground is not available or nearby.

Where all-wave coverage is desired, that is good reception for all frequencies, the best answer generally is, "the higher and longer the antenna, the better." Where particularly good reception is desired for a given frequency or band of frequencies, it is best to use an antenna designed for the frequencies in which you are interested. Several books on antennas are probably available from your local library. The ARRL (American Radio Relay League, West Hartford, Connecticut) Handbook contains information on antennas.

The wire used for the antenna may be either bare or insulated, but the lead-in wire from the antenna should be insulated where it touches other objects, such as poles, metal house siding, window stripping, etc. "Egg insulators," obtainable at your local hardware store, make excellent insulators where the antenna is tied to supporting structures. All wire splices or connections should be soldered to prevent noisy or erratic reception. Frequently a tree or pole may be used as one support and your house as the other. For a long antenna, it may be necessary to support the wire one or more times, near the middle. A copper coated steel wire (commercially known as "copperclad") makes excellent antenna wire and can be run for long spans without center supports.

### ANTENNA TERMINALS

The type of antenna you use will have a great bearing on the overall performance of the Radio. It will also determine which antenna terminal will provide the most satisfactory results.

On Bands A and B, it is probable that the LONG ANTENNA input will provide better results, regardless of the length of antenna used. In areas where a strong broadcast signal is present, the use of the SHORT ANTENNA input may result in the strong station being heard in the background when tuning other stations. The use of the LONG ANTENNA input will result in much greater rejection of the unwanted signal, although some difficulty may still be experienced when tuning for weak signals close to an unwanted strong one.

On Bands C and D, using a relatively short antenna (say less than 50 feet), the SHORT ANTENNA input may provide better results. It should be pointed out that using the SHORT ANTENNA input will disturb the dial calibration and frequency range. It will be necessary to set the Main Tuning slightly higher than indicated on the dial to receive the same station. For proper dial calibration, the FINE TUNING pointer should be set straight up and the LONG ANTENNA terminal used.



## OPERATION

### CONTROLS

**ON-OFF/VOLUME CONTROL** - Turns the Radio on or off and varies the volume heard from the speaker or headphones.

**REGENERATION CONTROL** - Adjustment for the amount of regeneration in the detector circuit.

**BAND SWITCH** - Selects one of the four frequency ranges: A, B, C, or D.

**MAIN TUNING** - Tunes in the desired station. Note that the innermost dial (Band A) is calibrated in kilocycles (or thousandths of a megacycle), whereas the remaining bands are calibrated in megacycles; 1000 kc equals 1 mc.

**FINE TUNING** - Allows a finer adjustment or separation of the signals tuned with the Main Tuning control. In effect, this control tunes a very small portion of the frequency range where the Main Tuning control is set. For proper calibration of the main dial, the FINE TUNING control pointer should be set straight up. Then, with a signal tuned in on the main dial, the FINE TUNING will allow tuning signals slightly higher (turning clockwise from straight up) or lower (counterclockwise) than the setting on the main dial. This control is particularly useful on the higher frequencies (Bands C and D), although it is usable on all bands.

**PHONES** - Inserting a headset plug into this jack transfers the output of the Radio to the headset. A second speaker (4 or 8  $\Omega$ ) can also be plugged in this jack, in which case both speakers will operate at slightly reduced maximum volume.

### OPERATIONAL PROCEDURE

With antenna and ground leads attached and the BAND switch in the Band B position (broadcast coverage), turn both the VOLUME and REGENERATION controls fully clockwise and allow about one-half minute for warmup. In turning the Main Tuning dial, a series of beat notes or whistles will be heard which will decrease in pitch upon nearing a station, and increase as you are tuning away from the station. When listening to voice stations, the REGENERATION control should be set just below the point of oscillation; that is, just counterclockwise to

where the beat notes disappear. At this point, maximum sensitivity and selectivity will be achieved. It should be pointed out that this optimum setting of the REGENERATION control will change as the Main Tuning dial is rotated over any great distance and also will change from band to band. The tuning procedure on all bands is identical to this example.

For tuning CW (code stations), single-sideband (SSB), teletype, Consolan, or other stations requiring a beat note for reception, the REGENERATION control should be advanced into the oscillating condition. Maximum sensitivity here will occur when the detector is just barely oscillating. On strong signals it may be desirable to advance the control somewhat further to prevent "pulling" of the oscillating frequency by the incoming signal. This is particularly important when listening to a strong SSB station.

When tuning the upper extremes of Bands C and D, advancing the REGENERATION control may cause the detector to pass from the regenerative condition to the oscillating condition and, with further advancement, go on into "super-regeneration." This is a state where the detector actually goes in and out of oscillation at a very rapid rate (generally supersonic) and is a very sensitive condition of the detector which may be used for voice signals. For CW signals and others requiring a beat note, it will be necessary to "back down" the control into the oscillating condition, which may be a more critical adjustment than on the lower frequencies.

As mentioned previously, the FINE TUNING control may be used as a fine adjustment of the Main Tuning dial for more accurate tuning of an SSB or CW station, for instance. It should also be noted that not all tones or whistles received are the result of the detector being in oscillation. Some stations transmit a tone (aircraft beacons, etc.), while in other cases beat notes may be the result of two stations operating quite close to each other in frequency.

Band C may not show much activity during the daytime as signals in this frequency range generally do not travel great distances except at night (up to several hundred miles maximum during daytime).

## SPECIFIC CHECKS

1. TUBES-PILOT LAMP - If the pilot lamp and tubes do not light properly, this would indicate that the trouble is in the power supply section, associated with the 35W4 tube (V3). Possible causes could be:

Open fuse.  
On-off switch open or wired improperly.  
Defective tube (any of the three as the heaters are wired in series).  
An error in the tube heater wiring.  
Open resistor R10 or R11.  
Open isolation transformer winding or open filter choke.  
Filter capacitor wired improperly or shorted (note that only two of the three sections of C11 are similar, the third is electrically different).  
A short circuit in any chassis wiring or component electrically common to pin 6 of the 50C5 tube (V2).  
Leads of pilot lamp shorted together.

2. AUDIO OUTPUT STAGE - If all tubes and the pilot lamp light properly, there should be a faint hum heard in the speaker (head-phone plug removed). If this is not the case, this would tend to indicate trouble in the 50C5 tube (V2) section, such as:

Defective 50C5.  
Wiring error in the output transformer (T2), speaker, or PHONES jack circuitry.  
Open output transformer, shorted capacitor C10 or open resistor R7 or R8.

3. AUDIO TEST - Turn the VOLUME control completely clockwise and the REGENERATION control fully counterclockwise. Now, very carefully touch lug 7 of the 12AT7 tube socket (V1) with the tip of a metal screwdriver while making contact with the screwdriver blade with your finger. A loud buzz

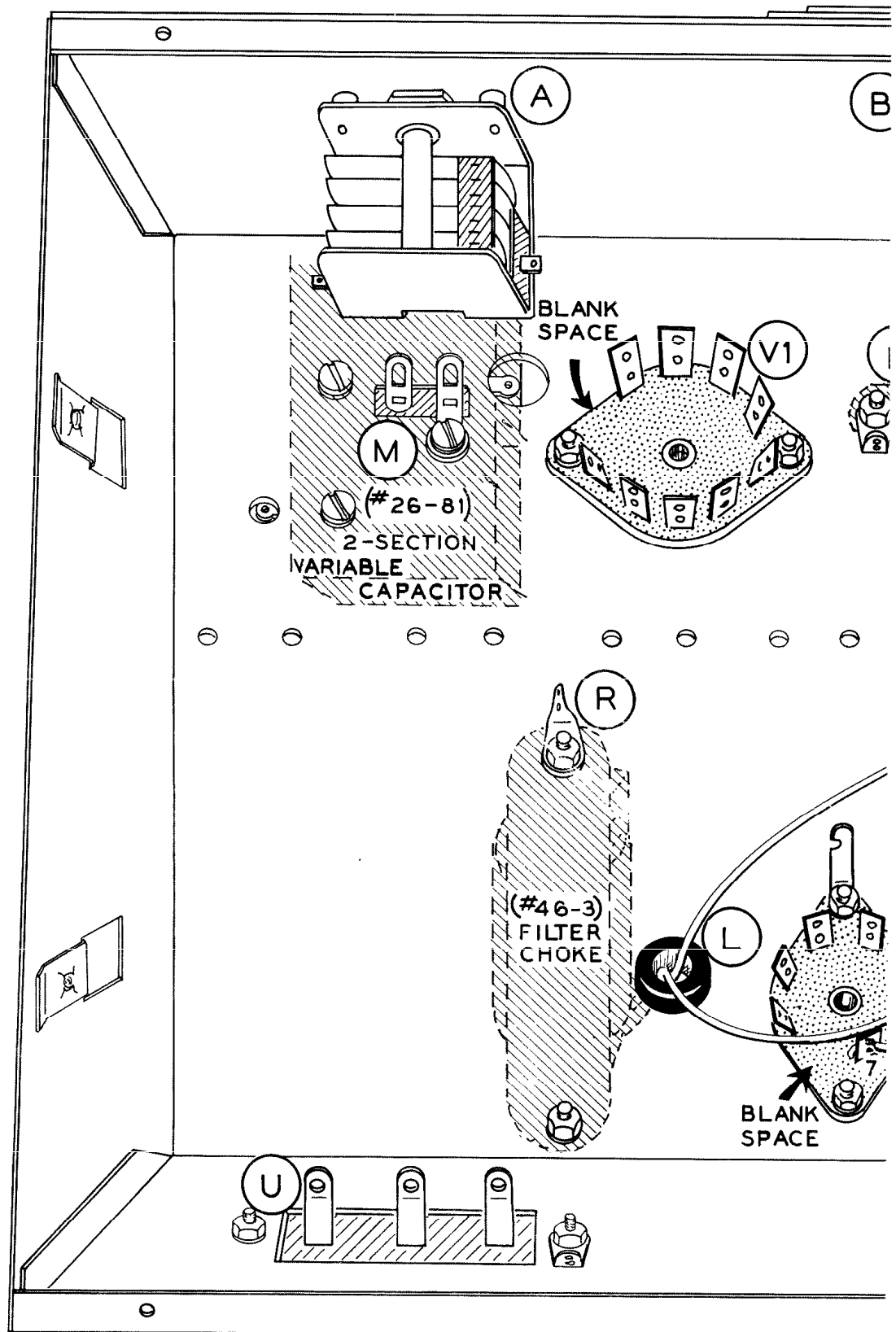
or hum should be heard in the speaker. Be very cautious not to touch anything else. Failure to obtain proper results here might be caused by:

Defective 12AT7 tube (V1).  
Center conductor of the shielded wiring shorted to chassis or shield braid.  
Defective resistor R4, R6, R7 or capacitor C9.

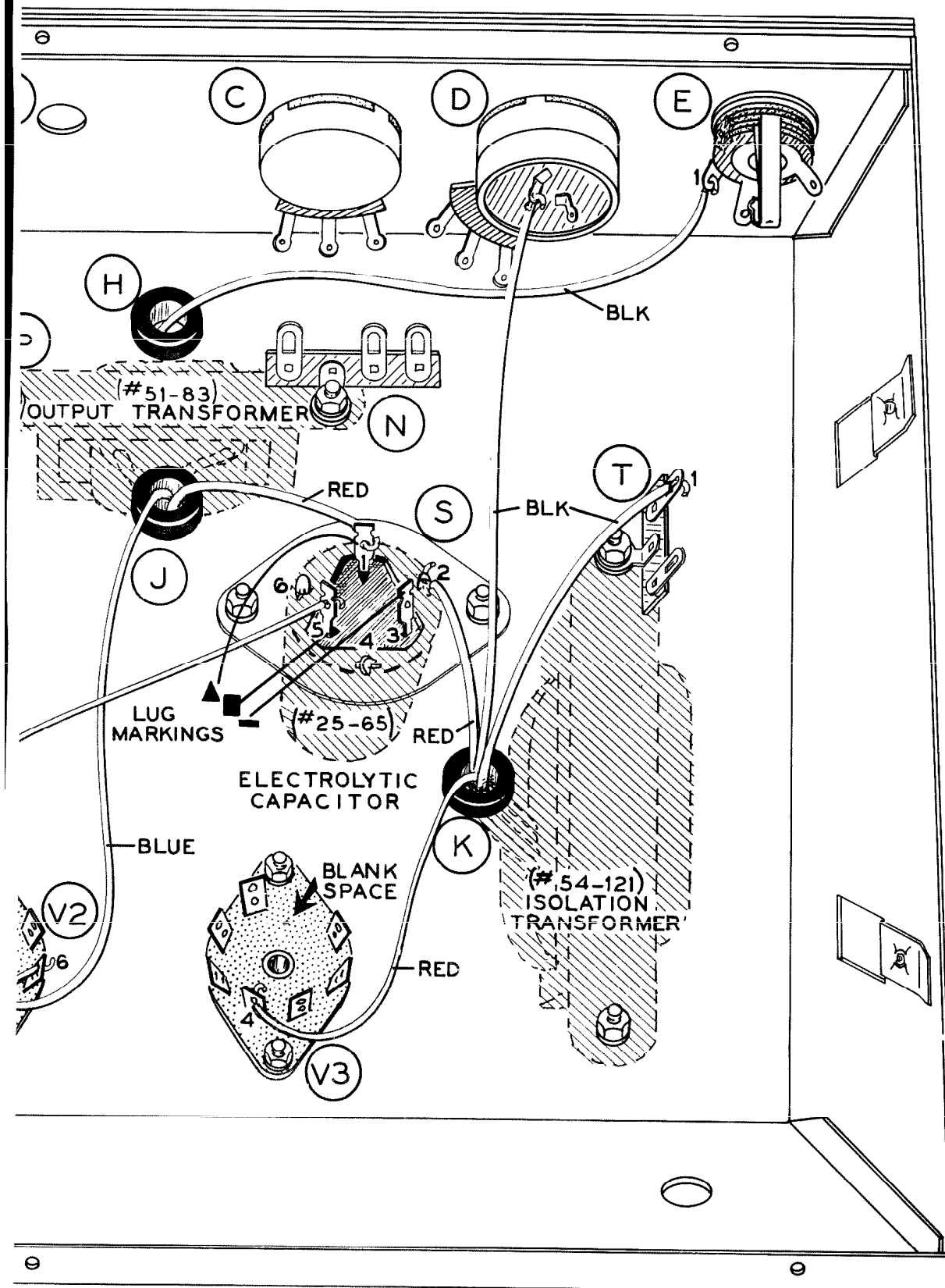
4. DETECTOR - Advance the REGENERATION control approximately one-quarter turn with the VOLUME control on full; as described earlier, and again using caution, touch lug 2 of the 12AT7 socket (V1) with the screwdriver. A loud hum should be heard, although it should sound somewhat different and louder than at lug 7 in the previous step. Failure to obtain proper results here could be caused by:

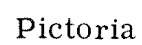
Defective 12AT7 tubes.  
Short circuit in the tickler section of the BAND switch wiring.  
Shorted capacitor C6, or shorted or open capacitor C7.  
Open RFC (L5).  
Open resistor R2 or R3.

5. COIL AND BAND SWITCH SECTION - If all tests so far check out, a careful inspection of the coil and BAND switch wiring is in order. It would be desirable to check the voltages present on tube socket V1 with a vacuum tube voltmeter. Note that the voltage on the plate of the detector (pin 1 of the 12AT7) will vary as the REGENERATION control setting changes, increasing with clockwise rotation. The voltage at the grid (pin 2) should also vary negatively in the same manner, but should remain constant over a portion of the counterclockwise range of the REGENERATION control.

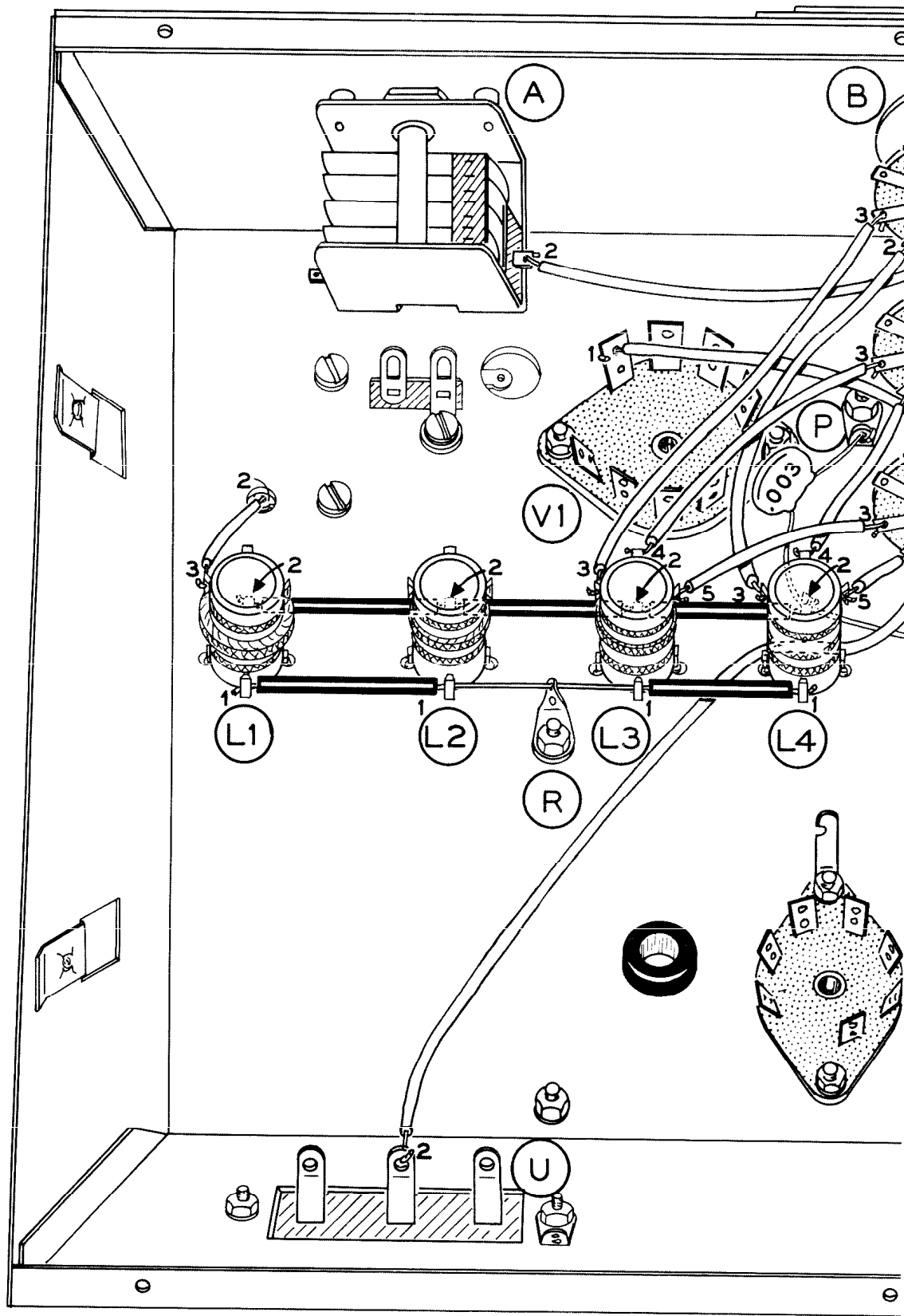


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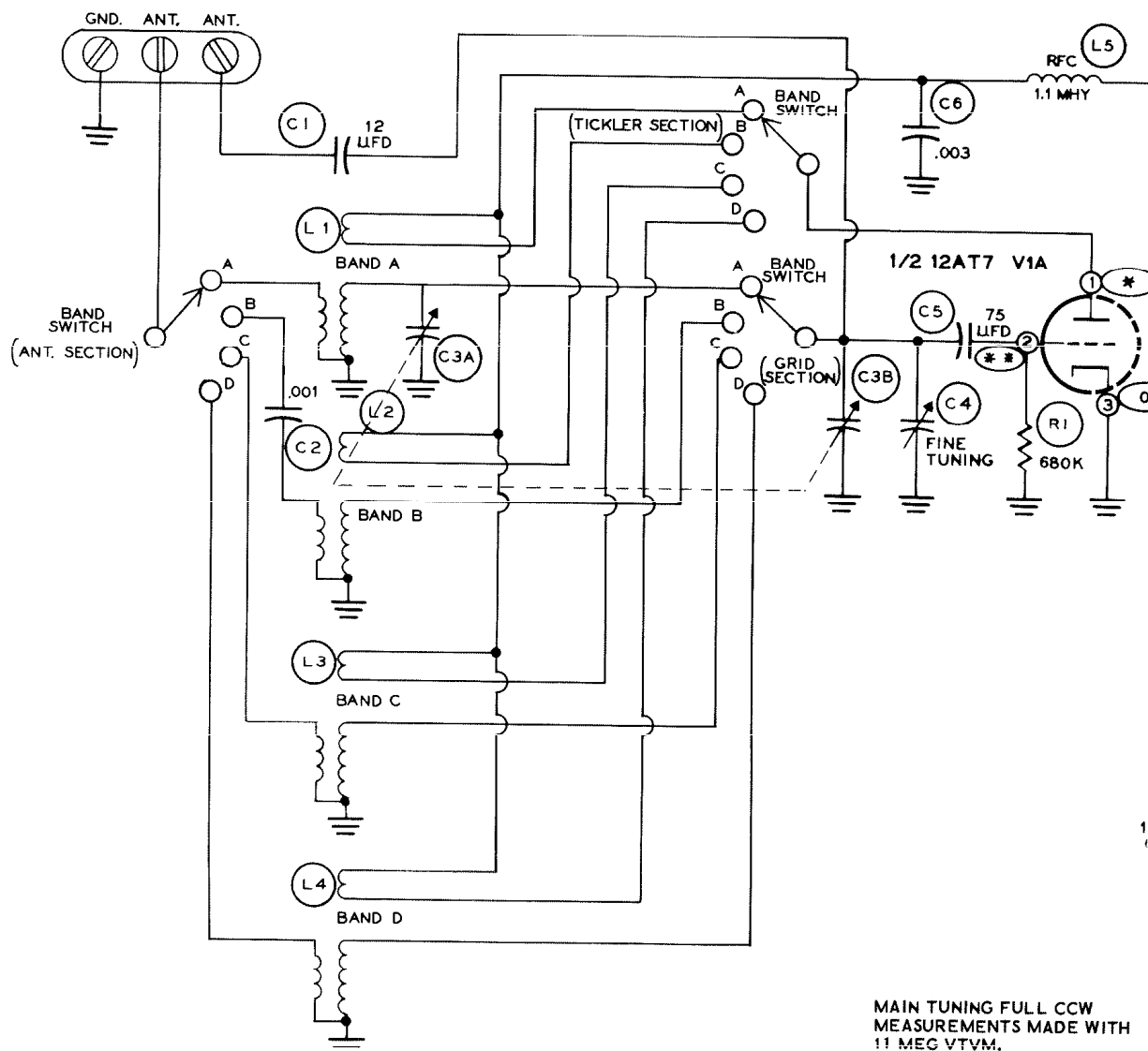












**SCHEMATIC OF THE  
HEATHKIT®  
SHORT WAVE LISTENERS RADIO  
MODEL GR-81**

MAIN TUNING FULL CCW  
MEASUREMENTS MADE WITH  
11 MEG VTVM.  
NO ANT-NO SIGNAL.  
ALL VOLTAGES DC UNLESS OT  
INDICATED AND POSITIVE WITH  
TO CHASSIS.  
\*0-40 VOLTS DEPENDING UPON  
OF "REGENERATION" CONTROL  
\*\* -0.5 VOLTS WITH REGENER/  
FULL CCW TO SEVERAL VOLT/  
WITH CONTROL FULLY CW.

