

# ASSEMBLY AND OPERATION OF THE HEATHKIT VARIABLE FREQUENCY OSCILLATOR

MODEL VF-1



## SPECIFICATIONS

Output Frequencies.....	1750-2000, 7000-7425, 6740-6808
Calibrated Bands.....	160-80-40-20-15-11-10
RF Output.....	Approximately 10 volts
Tube Complement.....	6AU6 - Oscillator OA2 - Voltage Regulator
Power Requirements.....	6.3 V AC at .45 A, 250-350 DC at 15-20 MA
Cabinet Size.....	7" high x 6 1/2" wide x 7" deep
Net Weight.....	4 lbs.



## INTRODUCTION

The Heathkit model VF-1 Variable Frequency Oscillator was designed to provide the Ham Fraternity with an economical, yet very stable, VFO which is so necessary for operation in today's crowded bands. It has sufficient output to drive any multi-stage transmitter of modern design on all bands from 160 through 10 meters. If operation of the 6 or 2 meter bands is desired, the 11 meter padder condenser may be adjusted to give fundamental frequencies down to 6 mc from the VFO. With suitable doubling, the 6 and 2 meter bands may be operated with the 8th or 24th harmonic of the VFO.

The VF-1 is wired to operate with the Heathkit AT-1 Transmitter by merely plugging into the proper receptacles on the AT-1. With any other transmitter, simple adapters can be used to obtain the necessary connections.

## CIRCUIT DESCRIPTION

The primary consideration in the design of any device which determines the operating frequency of a transmitter is stability. Stability in turn is dependent upon both the electrical and mechanical characteristics of the unit. Mechanical stability may be defined as freedom from vibration or any movement of the frequency determining components. Electrical stability means that the electrical characteristic of the components must not change during circuit operation. Neither of these conditions can be completely obtained but certain precautions can be taken to minimize mechanical instability and most forms of electrical instability can be compensated for.

The quartz crystal "rock" has excellent frequency stability because its small size and rigid mounting practically preclude mechanical instability and if operated at the moderate grid currents characteristic to small tetrode or pentode tubes, the heating effect of RF currents is small and has little effect upon frequency. However, the crystal oscillator gives no freedom of movement, consequently the self-excited oscillator has returned to the fold in new dress.

Mechanical stability in the Heathkit VFO has been achieved in the following manner. The coils are wound on heavy ceramic forms using litz or double cellulose wire then coated with Q-Max and baked. Double bearing construction is used on the tuning capacitor and both coils and capacitor mounted on a sub-assembly to make them independent of the panel. The frequency determining components are enclosed in a separate compartment to maintain rigidity, shielding and isolation from the hotter elements of the circuit. The padding and temperature compensating capacitors are also mounted on or in this compartment, thus maintaining all the frequency determining components at the same temperature.

One of the primary electrical causes of frequency shift in self-excited oscillators is due to changes in tube capacitance with applied filament and plate voltage. There are two basic methods used to lessen this effect. (1) Swamp the tuned circuit with a large amount of capacity so that any change in tube capacitance will be small by comparison (high C VFO). (2) Present a very low impedance tuned circuit for the tube grid to look into (series tuned Colpitts or Clapp oscillator).

The Heathkit VF-1 uses the series tuned Colpitts circuit which besides having the low impedance tuned circuit, also contains a considerable amount of swamping capacity in the form of a capacitive voltage divider. This voltage divider, consisting of two 510  $\mu\text{uf}$  capacitors, is necessary in a Colpitts circuit to supply in-phase voltage from the grid to cathode to maintain oscillation. The series tuned circuit of the VF-1 consists of two separate coils and two separate stator sections of a differential capacitor to develop the basic output frequencies. By using two tuned circuits, a better LC ratio and bandwidth is obtained over a wide range. Padder capacitors are placed in parallel with the sections of the differential tuning capacitor for adjustment and an additional padder capacitor is switched in to cover the 11 meter range. Rigidly mounted iron core slugs compensate for small variations of coil inductance and ceramic temperature compensating capacitors correct the frequency deviation due to coil heating.

The 6AU6 tube operating in a Clapp oscillator circuit is also operating as an electron coupled oscillator. In this circuit the tube's screen grid acts as the plate of the oscillator circuit with its voltage stabilized at 150 volts by the OA2 voltage regulator tube. The tube plate is coupled to the oscillator section only by the electron stream and further isolated by grounding the suppressor grid. Thus the plate circuit operates substantially independent in relation to the oscillator section of the tube. This increases the isolation between the oscillator and the following load and minimizes the effect of loading upon frequency.

The use of slug-tuned coils in the plate circuit of the 6AU6 provides relatively broad banding yet maintains a fairly high output. Two coils are operated in series for the lower frequency bands. The higher inductance coil is shorted out when operating on higher bands.

The VFO output is capacitively coupled through a 50  $\Omega$  coaxial cable to the transmitter. A plastic plug which will fit 1/2" spaced crystal sockets is furnished with the kit. If so desired, the builder can substitute a coaxial plug without any ill effects to VFO operation. Power for the VF-1 is obtained from the transmitter or an auxiliary source by means of a 3-wire shielded cable and an octal plug. The octal plug wiring shown in the manual is designed to fit the Heathkit AT-1 Transmitter. It may be changed to fit any other transmitter that the builder may have.

#### NOTES ON ASSEMBLY AND WIRING

The Heathkit model VF-1 Variable Frequency Oscillator when constructed by carefully following the instructions set forth in this manual, will result in a highly stable and reliable VFO capable of years of trouble-free service. All of the components furnished with the VF-1 are of the highest quality and should last indefinitely under normal service. Tubes may have to be replaced after their normal lifetime but due to the type of circuit used, this will have very little effect upon calibration.

The VF-1 is easily constructed and can be completed in a fairly short time. However, the very nature of the instrument is such that the highest quality of workmanship should be exercised in its construction. We therefore urge you to take the necessary time to assemble and wire the kit carefully. Do not hurry the work and you will be rewarded with a VFO that can be entrusted with the frequency control of your transmitter.

This manual is supplied to assist you in every way to complete the VFO with the least possible chance for error. We suggest that you take a few minutes now and read the entire manual through before any work is started. This will enable you to proceed with the work much faster when construction is started. The large fold-in pictorials are handy to attach to the wall above your work space. Their use will greatly simplify the completion of the kit. These diagrams are repeated in smaller form within the manual. We suggest that you retain the manual in your files for future reference, both in the use of the VFO and for its maintenance.

**UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST.** In so doing you will become acquainted with each part. Refer to the charts and other information shown on the inside cover of the manual to help you to identify any parts about which there may be a question. If some shortage is found in checking the parts, please notify us promptly and return the inspection slip with your letter to us. Hardware items are counted by weight and if a few are missing, please obtain them locally if at all possible.

Read the note on soldering on the inside of the back cover. Crimp all leads tightly to the terminal before soldering. Be sure both the lead and terminal are free of wax, corrosion or other foreign substances. Use only the best rosin core solder, preferably a type containing the new activated fluxes such as Kester "Resin-Five," Ersin "Multicore" or similar types.

**NOTE: ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE INSTRUMENTS IN WHICH ACID CORE SOLDER OR PASTE FLUXES HAVE BEEN USED. WHEN IN DOUBT ABOUT SOLDER, IT IS RECOMMENDED THAT A NEW ROLL PLAINLY MARKED "ROsin CORE RADIO SOLDER" BE PURCHASED.**

Resistors and condensers usually have a tolerance rating of  $\pm 20\%$  unless otherwise stated in the parts list. Therefore, a 100 K $\Omega$  resistor may test anywhere from 80 K $\Omega$  to 120 K $\Omega$ . The letter K is commonly used to designate a multiplier of 1000. Tolerances on condensers are generally even greater, limits of +100% and -50% are common for electrolytic condensers. The parts furnished with your Heathkit have been specified so as to not adversely affect the operation of the finished VFO.

In order to expedite delivery to you, we are occasionally forced to make minor substitutions of parts. Such substitutions are carefully checked before they are approved and the parts supplied will work satisfactorily. By checking the parts list for resistors for example, you may find that a 2.2 megohm resistor has been supplied in place of a 2 megohm as shown in the parts list. These changes are self-evident and are mentioned here only to prevent confusion in checking the contents of your kit. We strongly urge that you follow the wiring and parts layout shown in this manual. The position of wires and parts is extremely critical in a stable, calibrated VFO and changes may seriously affect the characteristics of the circuit.

### STEP-BY-STEP ASSEMBLY INSTRUCTIONS

The following instructions are presented in a simple, logical, step-by-step sequence to enable you to complete your kit with the least possible confusion.

Be sure to read each step all the way through before starting. When a step is completed, check it off in the space provided. This makes it easy to resume construction after your work has been interrupted.

NOTE: We suggest that you do the following before any work is started.

1. Select from the large fold-in pictorials included with the manual, the diagram showing the phase of construction you are engaged in at the time. Attach this diagram to the wall above your work space.
2. After identifying the parts from the parts list, place them in a large shallow box so that they are readily accessible. This will save considerable time in construction.
3. Read thoroughly the assembly and wiring instructions on the inside rear cover of the manual and refer to the general information on both inside covers of the manual to identify the parts.
4. In assembling the kit, use lockwashers under all nuts unless a solder lug is used.

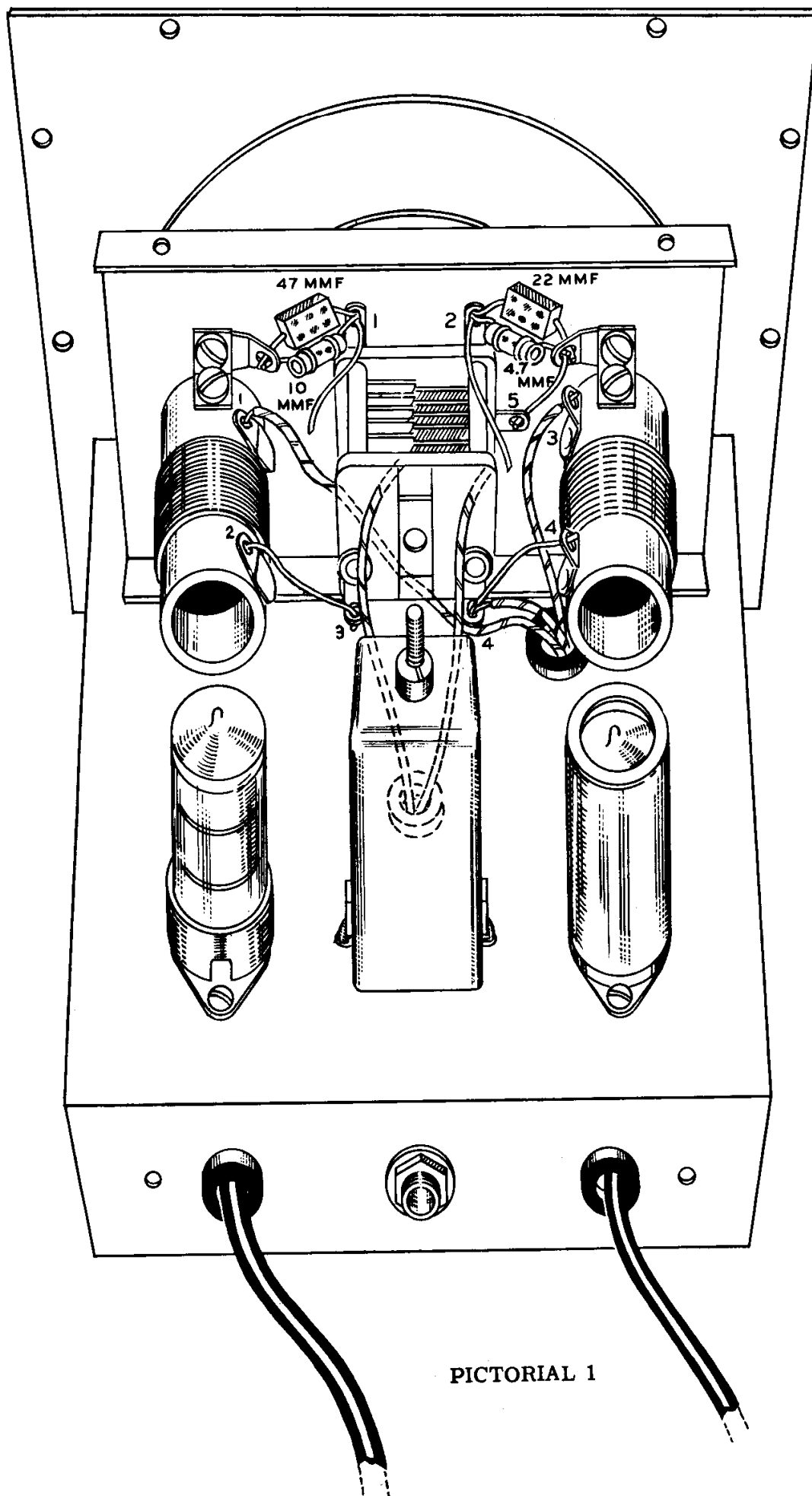
Tube sockets are mounted with the metal flange on top of the chassis. All screws have their heads on top or outside of the chassis. This construction may be noted by referring to Figure 4. Unless otherwise stated, 6-32 screws, lockwashers and nuts are used in mounting of parts.

### ASSEMBLY AND WIRING

(S) means solder.

(NS) means do not solder yet.

- X (✓) Mount the differential tuning capacitor to the front plate of the sub-chassis as shown in Figure 1 and Pictorial 1. Use a 3/8" lockwasher on the rear of the sub-chassis and a flat washer and 3/8 nut on the front. Position the capacitor so that the stator sections appear as shown in Figure 1 and the capacitor terminal lugs appear as shown in Pictorial 1.
- X (✓) Mount the 40 meter ceramic coil (one having the least number of turns) on the sub-chassis on the side of the capacitor having only two stator plates, as shown in Figure 1. Use assembly method shown in Figure 2. The coil terminals should be toward the capacitor. The position of this coil will hereafter be referred to as the right side as viewed from the rear. Use care in mounting the coils to prevent damage to the ceramic form.



PICTORIAL 1

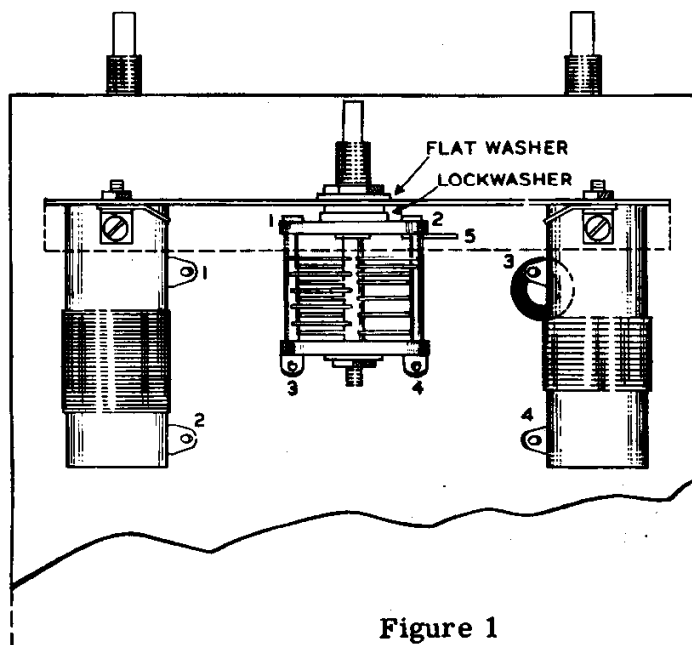


Figure 1

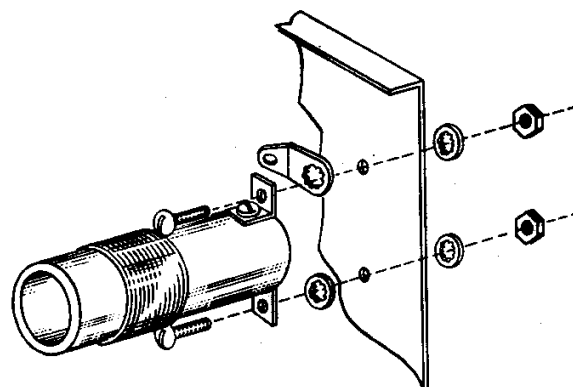


Figure 2

X (✓) Mount the 160 meter coil on the left side of the sub-chassis in the same manner, also with its terminals toward the capacitor.

X (✓) Connect a 22  $\mu\mu\text{f}$  silver mica capacitor (black-red-red-black-gold-red) from the ground lug under the top 40 meter coil mounting lug (NS) to terminal 2 on the tuning capacitor (NS). The capacitor should be mounted flat against the chassis with the leads no longer than necessary to make the connections.

X (✓) Connect a 4.7  $\mu\mu\text{f}$  negative 750 temperature compensating ceramic capacitor to the same points. Lay the ceramic capacitor tight against the mica capacitor (NS) as shown in Pictorial 1.

X (✓) Connect a short bare wire from the solder lug (S) to tuning capacitor terminal 5 (S).

X (✓) Connect a 2" length of bare wire to terminal 2 on the tuning capacitor (S). Leave the other end free.

X (✓) Connect a 47  $\mu\mu\text{f}$  silver mica capacitor (black-yellow-purple-black-gold-yellow) from the ground lug under the top 160 meter coil mounting lug (NS) to terminal 1 of the tuning capacitor (NS). Use the same procedure described above.

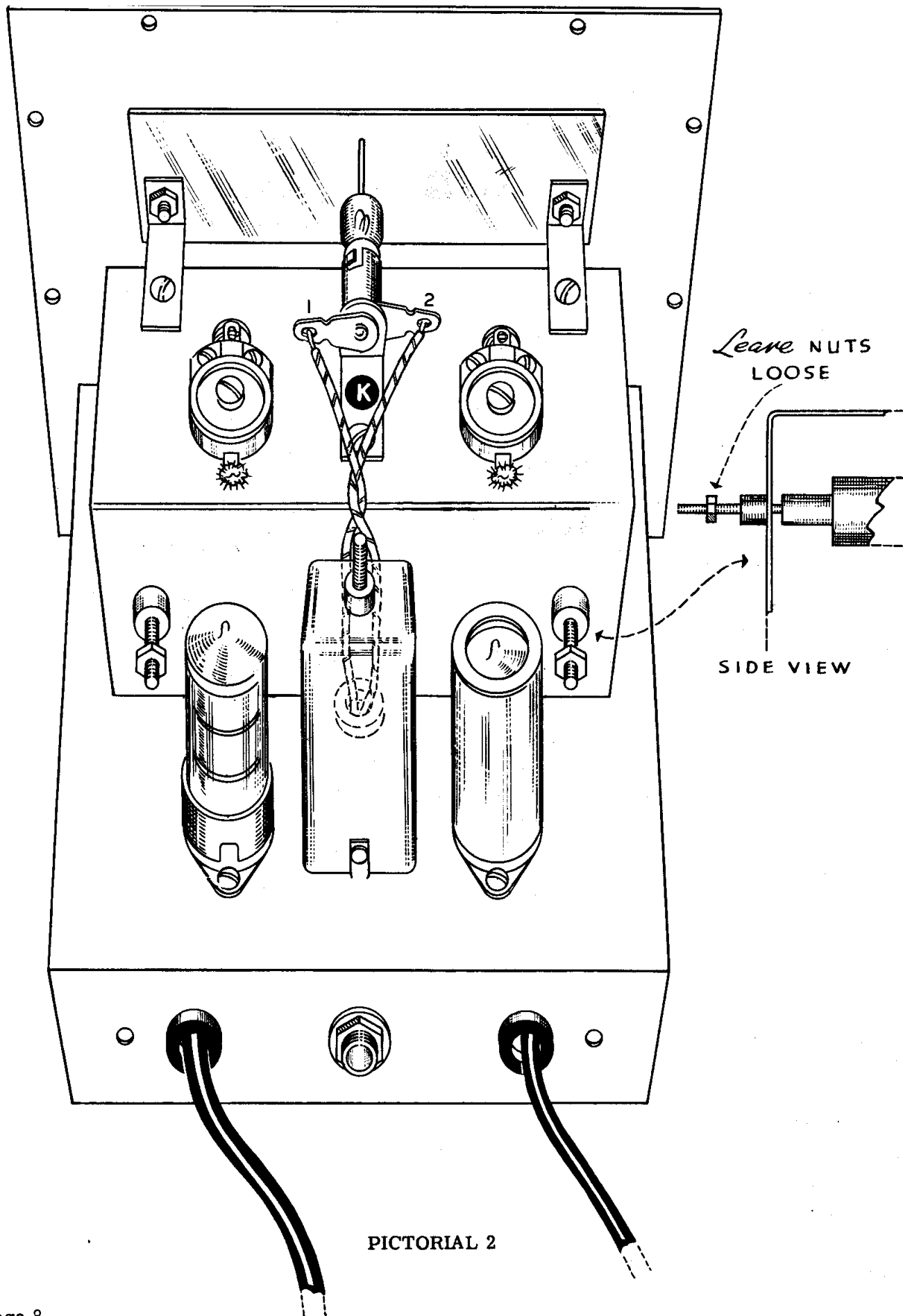
X (✓) Connect a 10  $\mu\mu\text{f}$  negative 750 ceramic capacitor to the same points in the same manner. Solder the ground connection only.

(✓) Connect a 2" length of bare wire to terminal 1 of the tuning capacitor (S). Leave the other end free.

Temporarily set this section aside.

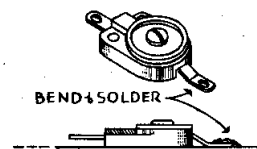
X (✓) On the L-shaped section of the sub-chassis, mount the pilot light socket K using a 6-32 screw through the socket and chassis with a lockwasher and nut on the under side. Position as shown in Pictorial 2 and tighten.

X (✓) Insert the two iron core slugs in the bushings on the back of the L section as shown in Pictorial 2. Add 6-32 nuts to slug shafts but do not tighten yet.



- X (✓) With a pair of long-nosed pliers, bend one terminal of all three 4.5-25  $\mu\mu\text{f}$  zero temperature coefficient ceramic trimmer capacitors, as shown in Figure 3. Use extreme care in bending to prevent damage to the capacitor and be sure to bend the correct terminal, as shown in the figure.

- X (✓) Using 4-40 screws and nuts, mount two of the capacitors on either side of the pilot light socket and position as shown in Pictorial 2. Tighten carefully and not too tightly or the ceramic will break.

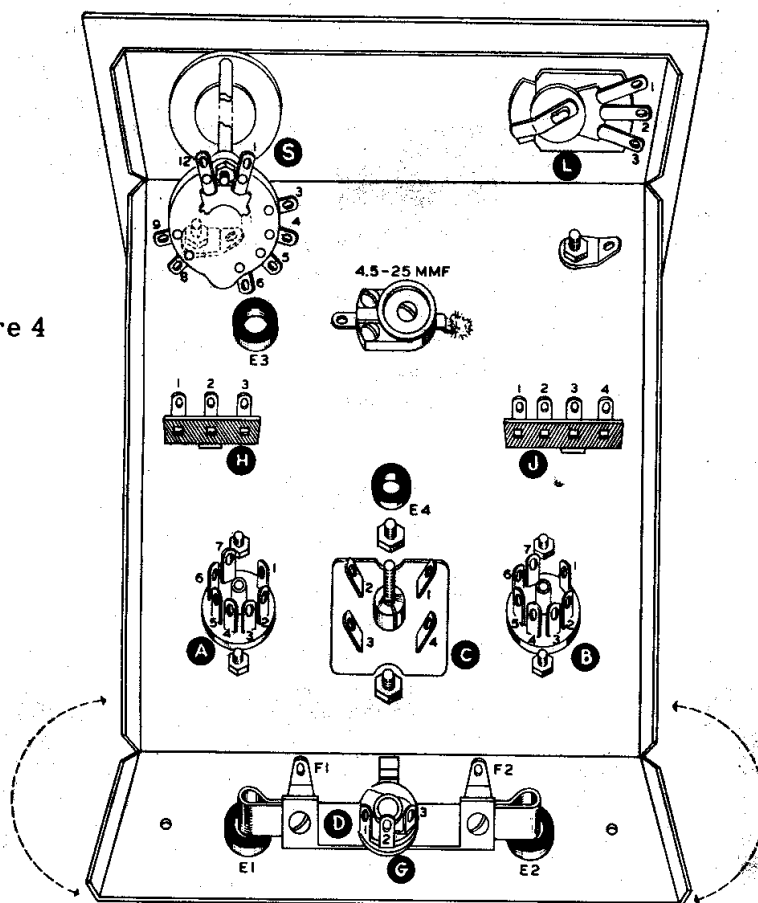


- X (✓) With a hot iron, solder the bent terminals to the chassis as shown in Pictorial 2. Figure 3

Set this section aside temporarily.

- X (✓) On the under side of the main chassis, mount the remaining 4.5-25  $\mu\mu\text{f}$  ceramic trimmer capacitor using 4-40 screws and nuts and taking the same precautions outlined above. Position as shown in Figure 4 and solder the bent terminal to the chassis.

Figure 4



- X (✓) Install 3/8" rubber grommets in holes E1, E2 and E3.
- X (✓) Install a 5/16" rubber grommet in hole E4.
- X (✓) Mount the two shielded ceramic sockets in holes A and B, using 3-48 round head screws and nuts (do not use the four semi-flathead screws here). Position the sockets so that the terminals appear as shown in Figure 4.
- X (✓) Mount the cable clamp bracket D to the rear apron of the chassis by means of the phone jack G, as shown in Figure 4. Position both as shown. Do not use a lockwasher here, but place a flat washer under the nut.

- X (✓) Examine the slug-tuned output coil. You will notice that the four terminals are numbered. Mount the coil as shown in Figure 4 with the #1 and #2 terminals toward the front of the chassis. Use 4-40 nuts on the spade lugs to secure the coil.
- X (✓) Mount the front sub-chassis to the main chassis with the 40 meter coil or right side over the grommet E3, using 6-32 screws. On the under side of the chassis, place solder lugs over each screw and position as shown in Figure 4. Lightly tighten the two nuts.
- I (✓) Assemble the tuning dial as shown in Figure 5, using the four semi-flathead 3-48 screws.
- X (✓) Mount the dial to the tuning condenser shaft using a 1/4" 8-32 set screw. Before tightening the set screw, adjust the dial so that the plastic rim is clear of and about 1/32" from the front skirt of the chassis. As it will be further adjusted later, do not tighten the set screw more than sufficient to hold the dial in place.
- X (✓) If necessary, loosen the screws holding the sub-chassis front plate and adjust it to allow the dial to rotate freely and parallel to the front apron of the chassis. It may be necessary to bend the plate slightly toward the back or front also to achieve perfectly parallel rotation of the dial on both the vertical and horizontal axes in respect to the chassis. After the dial has been properly adjusted, tighten the two nuts holding the sub-chassis securely.

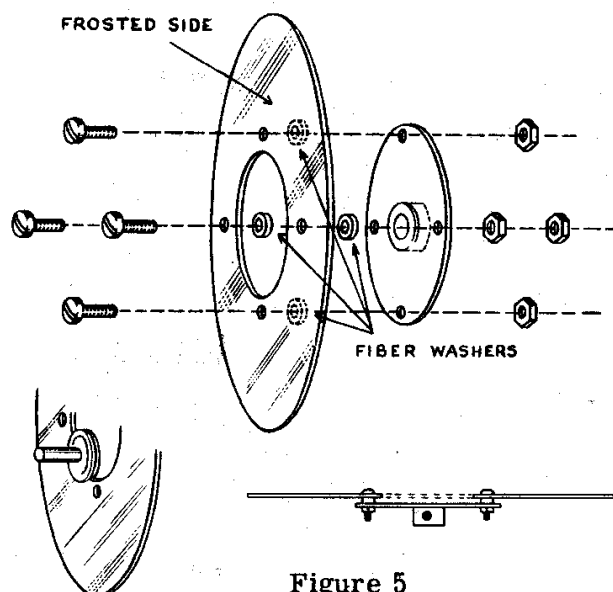


Figure 5

NOTE: The following wiring to the range switch can be more easily accomplished before the switch is mounted. In all the following instructions where a specific length of wire is mentioned, it should be stripped 1/4" at each end before installing.

- X (✓) Connect a 2 1/2" length of wire to S6 (S). Leave the other end free.
- X (✓) Connect a 5 1/2" length of wire to S5 (NS). Leave the other end free.
- X (✓) Cut one lead of a 22 K $\Omega$  resistor (red-red-orange) to 1/2" length and connect it to S5 (S). Leave the other end free.
- X (✓) Connect a 3 3/8" length of wire to S4 (NS). Leave the other end free.
- X (✓) Connect a short bare wire from S4 (S) to S3 (NS).
- X (✓) Cut one lead of a 2.2 K $\Omega$  resistor (red-red-red) to 5/8" length. Connect it to S3 (S). Leave the other end free.
- X (✓) Connect a 2" length of wire to S8 (S). Leave the other end free.
- X (✓) Connect a 3" length of wire to S9 (S). Leave the other end free.
- X (✓) After the switch is mounted, the wires coming from S4, S5 and S9 will go through the grommet E3.



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## PANEL MOUNTING

X (✓) Mount the drive bushing through the center panel hole from the rear. Place a flat washer and a 3/8" nut on the front and screw up to finger tightness.

X (✓) Insert friction drive shaft through this bushing from the rear. Do not put the knob on yet.

X (✓) Place the two switches through the chassis holes as illustrated in Figure 4 and Pictorial 3.

X (✓) Assemble the parts on the switch shaft in proper sequence as illustrated in Figure 6.

X (✓) On the range switch, slide wires coming from terminals S4, S5 and S9 through grommet E3.

X (✓) By tilting panel slightly forward after it is slid over the two switch shafts, and at the same time holding the friction drive shaft toward the rear, it will be possible to make the split washers of the friction drive wheels engage the plastic dial disk. See Figure 5. If the dial was placed too far from the chassis originally, it may be necessary to move it back slightly.

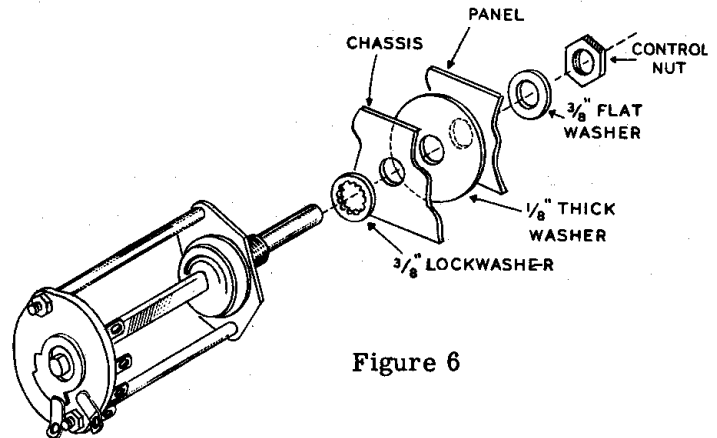


Figure 6

X (✓) When the drive is properly engaged, place flat washers and nuts over the switch shafts and tighten, being sure switches are positioned as shown in Figure 4 and Pictorial 3.

X (✓) There is a slight amount of clearance in the drive bushing panel hole. If the drive turns the dial without slipping, tighten the bushing nut securely. If not, make use of the hole clearance by pushing down on the shaft before tightening the nut. This will engage the drive more firmly. If too tight, reverse the above procedure.

X (✓) After the dial has been adjusted to rotate freely and the friction drive mechanism has been satisfactorily engaged, the dial must be matched with the tuning capacitor. To the left of the 7000 calibration, you will note a small line near the dial edge. Rotate tuning capacitor until rotor plates are completely meshed with the larger stator section, then loosen the dial set screw and turn the dial until this mark is centered in the panel opening. Retighten set screw.

X (✓) Using 1/4 x 8-32 set screws, mount the large round knob on the dial drive shaft and the two skirted knobs on the switch shafts. Align the skirted knobs to conform with panel markings.

X (✓) Connect a short bare wire from tuning capacitor terminal 4 (NS) to coil terminal 4 (S). See Pictorial 1.

X (✓) Connect the wire coming from S9 to tuning capacitor terminal 4 (S).

(✓) Connect the wire coming from S4 to coil terminal 3 (S).

X (✓) Connect the wire coming from S5 to coil terminal 1 (S).

X (✓) Connect a short bare wire from coil terminal 2 (S) to tuning capacitor terminal 3 (S).

X (✓) Mount the L-shaped sub-chassis plate to the main chassis using two 6-32 screws inserted with their heads above the chassis. Below the chassis, mount the two terminal strips H and J on these screws. Position as shown in Figure 4 and secure using lockwashers and nuts.

X (✓) On the slotted green plastic strip, mount two small L-brackets as shown in Figure 7.

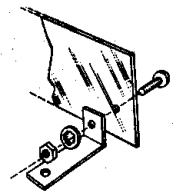


Figure 7

NOTE: In the next step, if any forcing is necessary to obtain hole alignment, do the bending on the L-plate only so as not to disturb the dial alignment.

- X(✓) Insert 6-32 screws through the small L-brackets then through the L-shaped sub-chassis plate and through the front sub-chassis plate as shown in Pictorial 2. Make sure the plastic strip just clears the dial when the latter is rotated and that the slot is centered in the panel opening. This can be checked by placing a light behind the unit and viewing it from the front. Secure the assembly with lockwashers and nuts.

#### FINAL WIRING

- X(✓) The two free bare wires coming from the tuning capacitor should be brought through the adjacent holes in the L-shaped sub-chassis and connected to the ceramic trimmer condensers. See Pictorial 2. Arrange the wires neatly and centered in the holes. Cut off excess lead wire and solder both connections.

- X(✓) Strip both ends of a wire 7" long and connect one end to K1 (S).

- X(✓) Strip both ends of a wire 11 1/8" long and connect one end to K2 (S).

- X(✓) Twist the two wires for a length of 4 1/2" and run through grommet E4.

For the following wiring refer to Pictorial 3:

- X(✓) Connect the short wire to J1 (NS).

- X(✓) Connect the long wire to L2 (NS).

- X(✓) Connect a bare wire from L3 (S) to the adjacent solder lug (S).

- X(✓) Connect one end of a wire 8 1/2" long to A4 (S).

- X(✓) Connect the other end to L2 (S).

- X(✓) Connect one end of a wire 5" long to L1 (S).

- X(✓) Connect the other end to J4 (NS).

- X(✓) Connect a wire 7 1/2" long to J4 (NS). Connect the other end to G2 (S).

- X(✓) On the range switch, connect the two loose ends of the 22 K $\Omega$  and 2.2 K $\Omega$  resistors to the adjacent solder lug. Arrange resistors neatly, cut off excess leads and solder.

- X(✓) Connect the wire coming from S8 to the ceramic trimmer capacitor (S). See Pictorial 3.

- X(✓) Connect the wire coming from S6 to H3 (NS).

- X(✓) Connect a wire 4" long from S12 (S) to C2 (S).

- X(✓) Connect a wire 4 1/8" long from S1 (S) to C1 (NS).

- X(✓) Connect a wire 2 1/2" long from C1 (S) to J2 (NS).

- X(✓) Connect a wire 2 1/2" long from C3 (S) to A5 (NS).

- X(✓) Connect a short bare wire from H3 (NS) to A1 (S). Arrange to clear chassis.

- X(✓) Connect a bare wire to H2 (NS). Run flat against chassis and through A2 to the center tube socket shield (NS). See Pictorial 3.

- X (✓) Connect a short bare wire from H1 (NS) to A7 (NS). Arrange to clear chassis.
- X (✓) Connect a 510  $\mu\text{f}$  silver mica capacitor (black-green-brown-brown-gold-yellow) from H3 (S) to H1 (NS).
- X (✓) Connect a 510  $\mu\text{f}$  silver mica capacitor from H1 (S) to H2 (S).
- X (✓) Connect a .005 disc ceramic capacitor from A2 (S) to A3 (NS).
- X (✓) Connect a 4 1/8" length of wire from A3 (S) to J1 (NS).
- X (✓) Connect a .005 disc ceramic capacitor from the center tube shield (S) to A6 (NS).
- X (✓) Connect a 6 1/2" length of wire from A6 (S) to B5 (NS).
- X (✓) Connect a 15 K $\Omega$  5 watt resistor from B5 (S) to J2 (NS).
- ~~X (✓)~~ Connect a bare wire from B7 (S) to J3 (NS).
- ~~X (✓)~~ Connect a .005 disc ceramic capacitor from J3 (S) to J2 (NS).
- ~~X (✓)~~ Connect one end of a 1.1 mh RF choke to A7 (S). Leave the other end free.
- ~~X (✓)~~ Cut both leads of a 100  $\mu\text{f}$  mica capacitor (white-brown-black-brown-silver-brown) to 1/4" length. Connect one lead to A5 (S). Leave the other end free.

#### PREPARATION OF CABLES

- ~~X (✓)~~ Strip 1" of the outer coating from both ends of the coaxial cable, comb out and twist the shield braid as shown in Figure 8.
- X (✓) Strip 1/4" from the inner insulation.

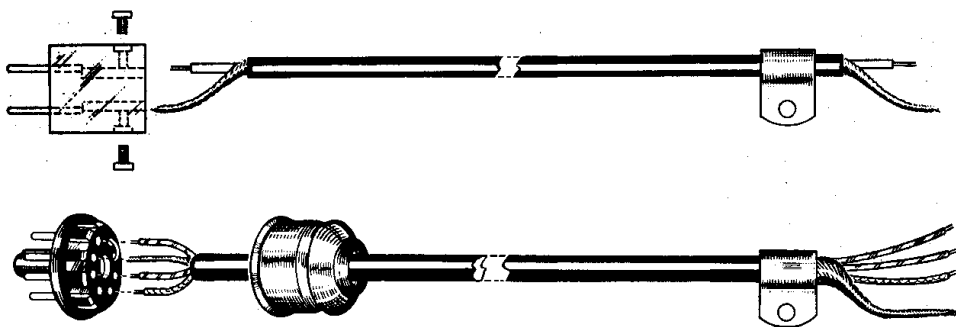


Figure 8.

- X (✓) Place a 3/16" cable clamp over the outer covering and insert cable through grommet E1 as shown in Pictorial 3.
- X (✓) Mount the cable clamp to the clamp bracket and include a soldering lug in the mounting as shown in Figure 9.
- X (✓) Connect a .005 disc ceramic capacitor from the solder lug (NS) to G1 (NS).
- X (✓) Twist the shield braid together and connect to the solder lug (NS).
- X (✓) Connect the inter coax conductor to the 100  $\mu\text{f}$  capacitor coming from A5 (NS). See Pictorial 3.

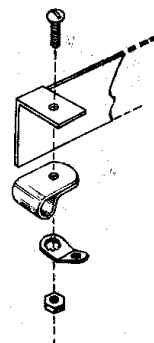


Figure 9

- (✓) Connect a 47 K $\Omega$  resistor (yellow-purple-orange) from this point (S) to the solder lug (NS).
- (✓) Connect a bare wire to the same solder lug (S). Run the wire along the back of the chassis through G3 (S). Leave 1" extended free past G3.
- (✓) Connect free end of the 1.1 mh RF choke to G1 (S).
- (✓) Strip off the outer covering for 3" on the 3-wire shielded cable.
- (✓) Place a 1/4" cable clamp over the outer covering as shown in Figure 9.
- (✓) Unwind the shield braid up to the cable clamp.
- (✓) Insert the cable through grommet E2 and secure the cable clamp and a solder lug to the bracket in the same manner used with the coaxial cable. See Figure 9 and Pictorial 3.
- (✓) Twist the shield braid together and connect to the adjacent solder lug (NS). Cut off excess braid.
- (✓) Connect the wire coming from G3 to the solder lug (S).
- (✓) Connect the red wire to J2 (S).
- (✓) Connect the green wire to J4 (S).
- (✓) Connect the yellow wire to J1 (S).
- (✓) Refer to Figure 8 and prepare the remaining end of the coaxial cable as shown.
- (✓) Tin both the inner conductor and the shield braid and connect to the crystal plug by tightening the plug screws on the wire and braid.
- (✓) Strip 1 1/2" of the outer covering from the 3-wire shielded cable, unwind the braid and re-twist it tightly.
- (✓) Slide the octal socket cap over the wire as shown in Figure 8 with the large end toward the wire end.
- (✓) The twisted braid is connected to pin 1 of the octal plug. ✓
- (✓) The red wire is connected to pin 4 of the octal plug. ✓
- (✓) The green wire is connected to pin 8 of the octal plug. ✓
- (✓) The yellow wire is connected to pin 2 of the octal plug. ✓
- (✓) Connect a jumper wire between pins 6 and 7 of the octal plug if the VF-1 is to be used with a Heathkit AT-1 Transmitter.

NOTE: For use with the VF-1, the Heathkit AT-1 Transmitter must have a wire connected from socket connections A5 to D6. This will bring the 6AG7 oscillator cathode to ground when the VFO power plug is inserted. In the event that both stages of the AT-1 are to be keyed, connect the jumper wire from pin 5 to pin 6 in the VF-1 power plug, and an additional wire from D5 to TB3 in the AT-1. If it is desired to key the VF-1 with the transmitter, connect an additional jumper from D5 to D8 in the AT-1 and leave the VF-1 panel switch in the STANDBY position.

NOTE.

## TESTING AND FINAL ASSEMBLY

NOTE: The instructions given here for testing will be based on use with the Heathkit AT-1 Transmitter. In the event another transmitter is used, follow the general procedure, remembering that the VF-1 power requirements must be provided for; 6.3 VAC at .45 amp and 250 to 350 VDC at 20 to 25 MA.

IMPORTANT WARNING: MINIATURE TUBES CAN BE EASILY DAMAGED WHEN PLUGGING THEM INTO THEIR SOCKETS. THEREFORE, USE EXTREME CARE WHEN INSTALLING THEM. WE DO NOT GUARANTEE OR REPLACE MINIATURE TUBES BROKEN DURING INSTALLATION.

- X (✓) Install the 6AU6 tube in socket A and cover with the tube shield.
  - X (✓) Install the OA2 tube in socket B, no shield is required.
  - X (✓) Install the pilot lamp.
  - X (✓) Plug the VF-1 power plug into the AT-1 VFO power socket and switch both VF-1 and AT-1 to STANDBY position. Turn on the AT-1 power switch.
  - X (✓) The pilot light on the VF-1 should light. If it doesn't, check to see if the VF-1 is plugged into the AT-1 modulator connection.
  - X (✓) Plug the VF-1 output connector into the AT-1 crystal socket with shield braid at the bottom.
- CAUTION: Before proceeding, be sure the AT-1 is connected to a dummy load, not to the antenna. As the VF-1 has not yet been calibrated, it might be operating far outside the band.
- X (✓) On the VF-1, set all three ceramic trimmer capacitors to mid position (screw slot in line with terminals) and screw both slugs in the output coil in until about 1/2" of screw thread is exposed.
  - X (✓) Switch the VF-1 range switch to the 160-80-40 position and the operation switch to ON position.
  - X (✓) Switch the AT-1 into 80 meter position, grid plate switch to plate position and standby switch to ON.
  - X (✓) Set VF-1 dial to about 3700 kc and tune the AT-1 output control for dip. Meanwhile monitor with your receiver. If a dip cannot be obtained, try again with VF-1 dial near either band edge 3500-4000. Be sure AT-1 Transmitter has been modified as explained above.
  - X (✓) After completing the step above, switch VF-1 to 40-20-15-10 position and the AT-1 to 20 meter position. Set the VF-1 dial for about 7100 kc. Tune the AT-1 driver and output controls in the same manner used with crystal operation. Check as above. If difficulty is encountered at this stage, see the trouble-shooting section farther on in this manual.
  - X (✓) At this stage, the slugs on the output coil may be roughly tuned for further output. The top slug controls the low frequency output and the bottom slug the high frequency output.
  - X (✓) Install rubber feet on cabinet as shown in Figure 10.
  - X (✓) Mount the VF-1 in the cabinet using #6 sheet metal screws. When sliding unit into the cabinet, take care not to damage the range switch or the plastic dial light shield against the cabinet flange. The VF-1 is now ready for final calibration.

## CALIBRATION

OK  
OK.  
If the kit constructor has access to one of the LM or BC frequency standards they are excellent for calibration. The other alternative is to accumulate as many crystals in the bands concerned as possible. The crystals preferably should be near the edge of the bands. A separate oscillator circuit for the crystals will be necessary so that both crystal oscillator and VFO can be beat against each other in the receiver. Before beginning calibration, allow the VF-1, crystal oscillator, frequency meter and receiver to warm up for one-half hour or more. If a BC 221 frequency meter or equivalent is used (do not use ordinary radio service generators) it should be set to 1750 kc. If a crystal oscillator is used, have the frequency as near as possible to 1750 or 3500 kc.

OK  
OK  
Set VF-1 dial to 1750 or to the crystal frequency used with the VF-1 bandswitch in the 160-80-40 meter position. Insert an insulated screwdriver type tuning wand through the right-hand hole on top of the cabinet as viewed from the front and engage the trimmer capacitor under the hole. Using the trimmer capacitor, tune the VF-1 for zero beat with the standard as heard in the receiver with the BFO off. The trimmer capacitors are very critical in tuning and tend to drift for a second after being moved so tune with extreme care and withdraw the wand for final checking.

Using the frequency meter or another crystal, check the dial at the high frequency end of the band. If the dial reading is higher than the actual frequency, screw in the slug on the same side as the trimmer capacitor. The slugs are accessible through the holes in the rear of the cabinet. Readjust the trimmer to read correctly at the high end of the dial and check frequency at the low end. If dial reads lower than actual frequency, screw slug in further and recheck. It may be necessary to repeat the steps several times before both ends of the dial read correctly. However, when they do the in-between calibration will have a high degree of accuracy. Inserting the slug further into the coil decreases the dial spread for a given frequency range.

After aligning the frequency to the dial in the step above, tune the VF-1 to about the mid-scale point and peak its output by adjusting the low frequency output coil. This adjustment is made by tuning the slug which is accessible at the rear top cabinet hole. The grid meter reading on the transmitter will indicate peak output. If the coil is very far off resonance, it will probably be necessary to slightly retune the trimmer capacitor. It should be rechecked at any rate.

When the low frequency range is calibrated to your satisfaction, switch to the 40-20-10 position and repeat the above steps using a 7 to 7.3 mc standard or appropriate crystals. The left-hand top cabinet hole will give access to the high frequency trimmer, the rear cabinet hole access to the slug, and the rear bottom cabinet hole access to the output coil. The last turn on the high frequency coil may have to be moved in extreme cases where the slug does not cover enough range. Moving turn closer to the winding duplicates screwing the slug in further and vice versa.

For 11 meter calibration, the frequency standard or crystals must operate at 6740 to 6808 kc. The trimmer is accessible through the front bottom cabinet hole. The switch must be in the 11 meter position.

After the VF-1 has been completely calibrated, remove from cabinet and tighten the nuts on the slug shaft against the bushings and replace in cabinet.

The VF-1 will hold calibration over a long time if properly cared for. However, any VFO should be checked for calibration from time to time. Remember, a VFO is by no means a frequency standard and if operation very close to a band edge is desired, a constant check must be kept upon its frequency.

## VFO OPERATION

By means of the OFF-STANDBY-ON switch, the VF-1 may be controlled independently of the transmitter or controlled by the transmitter. Thus with the key up on the transmitter, the VF-1 can be operated alone for tuning purposes, and incidentally, should be. It is definitely bad operating procedure to swish a VFO across the band with the entire transmitter following it. This causes needless interference to other stations. The VFO alone should be set to the desired frequency, THEN quickly tune the transmitter to resonance at the new frequency. This procedure produces far less interference and will not classify you as a "lid" among your fellow hams.

As was mentioned previously, crowding the band edges is not recommended unless a positive and constant check upon frequency is maintained. Particularly with a phone transmitter where the sidebands may run three or more kc over and under the base frequency. Even a single side-band transmitter can put some hash on the undesired sideband and create signals outside of the amateur band.

When plugging the VFO output into a crystal socket, be sure that the "hot" lead or center wire of the VFO plug is connected to the grid side of the crystal socket. If the VF-1 tends to overdrive the crystal stage, swamping resistance can be connected across the crystal socket.

The transmitter used in conjunction with the VF-1 must be free of parasitics or any tendency toward self-oscillation and must have the equivalent input power sensitivity of the average crystal oscillator stage.

#### IN CASE OF DIFFICULTY

Mistakes in wiring are the most common cause of difficulty. Consequently, the first step is to recheck all wiring against the pictorials and the schematic diagrams. Often having a friend check the wiring will locate an error consistently overlooked.

Also, with miniature sockets there is a possibility of shorts between adjacent socket terminals due to the close spacing. This should be checked and if any doubt exists, the terminal should be pried apart until obvious spacing can be seen between them.

Sometimes apparently good solder connections will have an insulating coating of rosin between the wire, terminal and solder. This is often the case when insufficient heat was applied in soldering. An ohmmeter check of connections, WITH ALL VOLTAGES OFF, will test this condition.

A voltage check at tube socket terminals will often indicate the reason for faulty operation. A table of voltages is shown below. These voltages were measured with a 20,000 ohm per volt multimeter, during VF-1 operation with the Heathkit AT-1 Transmitter.

*check.*

SOCKET A 6AU6	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7
Range Switch 160-80-40	-10	0	6.3 VAC	0	350	150	.2
Range Switch 40-20-15-10	-2	0	6.3 VAC	0	350	150	.4
Range Switch 11	-3	0	6.3 VAC	0	350	150	.4
SOCKET B OA2	150	0	NC	0	150	NC	0

NOTE: A VTVM should not be used to measure voltage as the presence of RF will invalidate the reading obtained. If a different source of power supplies the VF-1, the voltages in columns 1, 5 and 7 of socket A (6AU6) will change accordingly.

In the event that the voltages test approximately as shown and the VF-1 still will not oscillate, look for a possible short from tuning capacitor stator to ground or grounds at pins 1 or 7 of socket A. Also be sure that the 2.2 K $\Omega$  and 22 K $\Omega$  resistors are not reversed and that the 1.1 mh RF choke or the key jack does not present an open circuit to the tube cathode.

## REPLACEMENTS

Material supplied with Heathkits has been carefully selected to meet design requirements and ordinarily will fulfill its function without difficulty. Occasionally improper instrument operation can be traced to a faulty tube or component. Should inspection reveal the necessity for replacement, write to the Heath Company and supply all of the following information:

- A. Thoroughly identify the part in question by using the part number and description found in the manual parts list.
- B. Identify the type and model number of kit in which it is used.
- C. Mention the order number and date of purchase.
- D. Describe the nature of defect or reason for requesting replacement.

The Heath Company will promptly supply the necessary replacement. Please do not return the original component until specifically requested to do so. Do not dismantle the component in question as this will void the guarantee. If tubes are to be returned, pack them carefully to prevent breakage in shipment as broken tubes are not eligible for replacement. This replacement policy does not cover the free replacement of parts that may have been broken or damaged through carelessness on the part of the kit builder.

## SERVICE

In event continued operational difficulties of the completed instrument are experienced, the facilities of the Heath Company Service Department are at your disposal. Your instrument may be returned for inspection and repair for a service charge of \$3.00 plus the cost of any additional material that may be required. **THIS SERVICE POLICY APPLIES ONLY TO COMPLETED INSTRUMENTS CONSTRUCTED IN ACCORDANCE WITH THE INSTRUCTIONS AS STATED IN THE MANUAL.** Instruments that are not entirely completed or instruments that are modified in design will not be accepted for repair. Instruments showing evidence of acid core solder or paste fluxes will be returned not repaired.

The Heath Company is willing to offer its full cooperation to assist you in obtaining the proper operation of your instrument and therefore this factory repair service is available for a period of one year from the date of purchase.

## SHIPPING INSTRUCTIONS

Before returning a unit for service, be sure that all parts are securely mounted. Attach a tag to the instrument giving name, address and trouble experienced. Pack in a rugged container, preferably wood, using at least three inches of shredded newspaper or excelsior on all sides. **DO NOT SHIP IN THE ORIGINAL KIT CARTON AS THIS CARTON IS NOT CONSIDERED ADEQUATE FOR SAFE SHIPMENT OF THE COMPLETED INSTRUMENT.** Ship by prepaid express if possible. Return shipment will be made by express collect. Note that a carrier cannot be held liable for damage in transit if packing, in HIS OPINION, is insufficient.

## SPECIFICATIONS

All prices are subject to change without notice. The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

## WARRANTY

The Heath Company limits its warranty of parts supplied with any kit (except tubes, meters and rectifiers, where the original manufacturer's guarantee only applies) to a period of three (3) months from the date of purchase. Replacement will be made only when said part is returned postpaid, with prior permission and in the judgment of the Heath Company was defective at the time of sale. This warranty does not extend to any Heathkits which have been subjected to misuse, neglect, accident and improper installation or applications. Material supplied with a kit shall not be considered as defective, even though not in exact accordance with specifications, if it substantially fulfills performance requirements. This warranty is not transferable and applies only to the original purchaser. This warranty is in lieu of all other warranties and the

Heath Company neither assumes nor authorizes any other person to assume for them any other liability in connection with the sale of Heathkits.

The assembler is urged to follow the instructions exactly as provided. The Heath Company assumes no responsibility or liability for any damages or injuries sustained in the assembly of the device or in the operation of the completed instrument.

**HEATH COMPANY**  
Benton Harbor, Michigan

**PARTS LIST**

<u>PART No.</u>	<u>PARTS Per Kit</u>	<u>DESCRIPTION</u>	<u>PART No.</u>	<u>PARTS Per Kit</u>	<u>DESCRIPTION</u>
<b>Resistors</b>			<b>Hardware</b>		
1-22	1	22 K $\Omega$	73-1	3	3/8" rubber grommet
1-25	1	47 K $\Omega$	73-4	1	5/16" rubber grommet
1-44	1	2.2 K $\Omega$	204-M67	1	Cable bracket
3-6E	1	15 K $\Omega$ 5 watt	204-M68	2	Light shield bracket
<b>Capacitors</b>			206-25	1	1 3/4" tube shield
20-1	1	47 $\mu$ f silver mica	207-4	1	1/4" cable clamp
20-11	1	100 $\mu$ f mica	207-5	1	3/16" cable clamp
20-41	1	22 $\mu$ f silver mica	250-2	4	3-48 round head screw
20-42	2	510 $\mu$ f silver mica	250-8	8	#6 sheet metal screw
21-27	4	005 $\mu$ f ceramic	250-9	15	6-32 x 3/8 screw
21-28	1	10 $\mu$ f N 750 ceramic	250-34	6	4-40 x 1/2 screw
21-29	1	4.7 $\mu$ f N 750 ceramic	250-43	4	8-32 x 1/4 set screw
26-20	1	11-35 $\mu$ f dual variable	250-49	4	3-48 binder head screw
31-10	3	4.5-25 $\mu$ f NPO trimmer	252-1	8	3-48 nut
<b>Switches-Tubes</b>			252-3	17	6-32 nut
63-77	1	1 pole 3 pos. switch	252-7	5	Control nut
63-78	1	3 pole 3 pos. ceramic switch	252-15	8	4-40 nut
411-11	1	6AU6 tube	253-10	5	Control flat washer
411-59	1	OA2 tube	253-22	2	1/8 steel spacing washer
412-1	1	#47 pilot light	253-23	4	1/16 fiber spacing washer
<b>Coils-Chokes</b>			254-1	13	#6 lockwasher
40-54	1	160 M coil	254-4	3	Control lockwasher
40-55	1	40 M coil	259-1	6	#6 solder lug
40-56	1	Dual plate coil	261-1	4	Rubber feet
45-4	1	1.1 mh RF choke	455-6	1	1/4 shaft bushing
<b>Sockets-Terminal Strips-Knobs</b>			475-3	2	Iron core slug
431-10	1	3-lug terminal strip	<b>Miscellaneous</b>		
431-12	1	4-lug terminal strip	90-30	1	Cabinet
434-35	2	7-pin ceramic socket	100-M43	1	Dial drive plate
434-44	1	Pilot light socket	200-M65	1	Chassis
436-4	1	Phone jack	200-M66	1	Sub-chassis front
438-6	1	Octal plug	200-M67	1	Sub-chassis cover
438-10	1	Crystal plug	203-M60F80	1	Panel
440-1	1	Octal plug cover	206-M26	1	Light shield
462-19	2	Skirted knob	340-2	1	length #20 bare wire
462-26	1	Round knob	343-2	1	length Coaxial cable
			344-1	1	roll Hookup wire
			347-4	1	length 3-wire cable
			464-M3	1	Dial
			100-M44	1	Friction drive
			595-91	1	Manual

