Heathkit HG-10 VFO Modifications

Back in the 1960s, most new hams started out with a Novice license and a crystal-controlled transmitter. If they stuck to it and passed the General license exam, the first thing many of them bought next was a variable frequency oscillator (VFO) and never touched a crystal again. Heathkit, of course, was right in the middle of this and offered the VF-1 VFO kit followed later by the HG-10 and HG-10B.

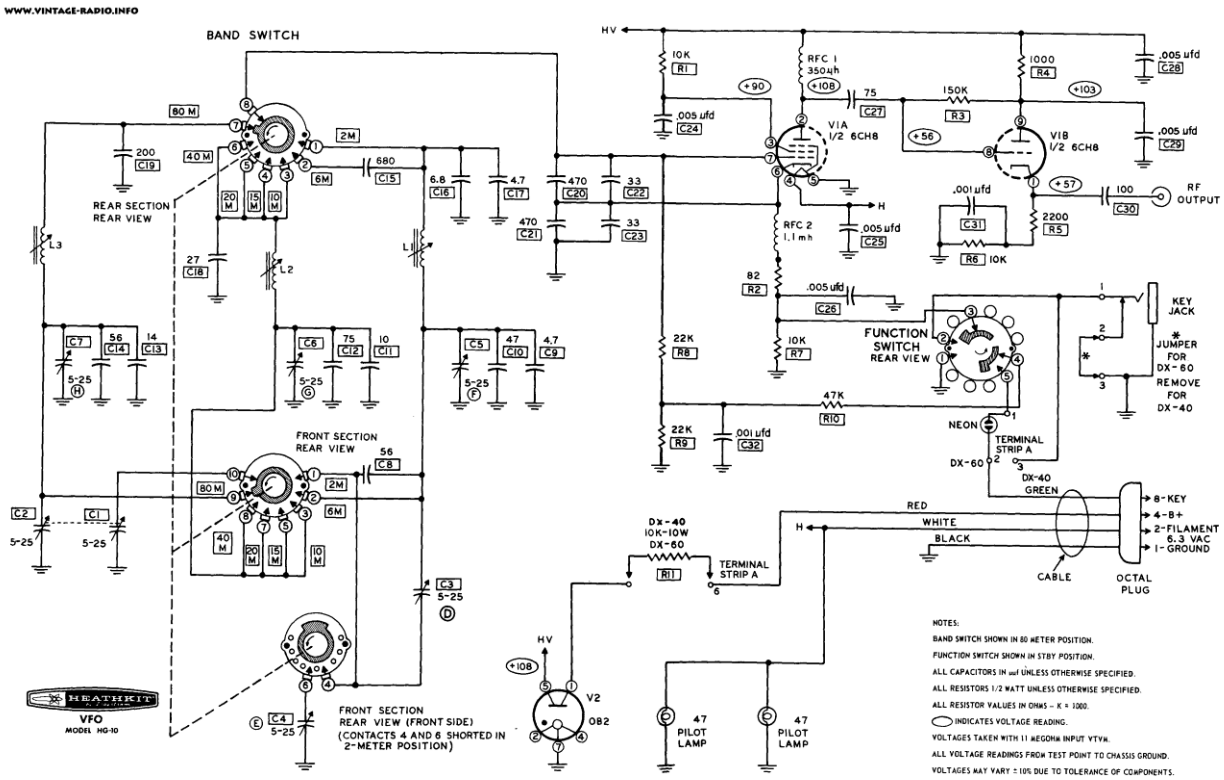
All of these are great little pieces of gear and there must be thousands of them still around. The stability doesn't match today's solid-state oscillators; however, after 30 mins or so of warm up they do a respectable job of driving an AM, CW, or SSB transmitter.

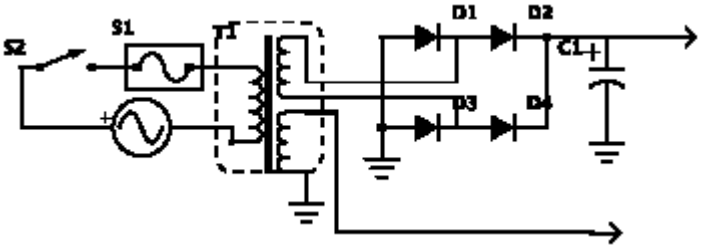
But, there is a problem. The VFO does not have a built-in power supply. Typically, power would be drawn from the transmitter. While this does work, in some if not all cases, the signal would have a chirp, i.e., on key down the voltage would change slightly. Even though the VFO contains a voltage regulator tube, this chirp is a common problem. The solution is to add a power supply to the HG-10.

There are couple of other minor problems. The plate RF choke was too small in the original design and resulted in somewhat low output and a bit of distortion in the output wave. Apparently, Heathkit later changed the value; or, at least changed the value on the schematic. The solution is to replace the choke with a larger value. Also, the vfo provides both cathode keying, e.g., DX-40, and grid bias keying, e.g., DX-60. However, switching from one to the other requires opening the cabinet and changing a couple of wires. The solution is to provide a separate grid-block keying jack. Actually, keying the vfo often means keying it when going to transmit mode, i.e., the VFO is always keyed in transmit mode and the carrier is turned on and off (keyed) at the transmitter. The exception would be for break-in operation in which case some sort of sequence keying arrangement is required to avoid the evil chirp.

The modifications addressing these issues are described below. There is nothing particularly critical about the modifications or the component values. As with most good old tube gear, anything in the ballpark will probably work fine.

1. Power supply: The fuse-protected power supply has a full wave bridge and 100 mfd of filter capacitance. It also provides 6.3 vac for the 6CH8 filament. An on/off switch was also added to the back apron; however, in practice it might be more convenient to leave the vfo on and switch it with the station power strip.
2. An RCA (phono) jack was added above the standard key jack. This RCA jack is for grid-block keying such as with a DX-60 and replaces the 8-Key connection in the octal connector.
3. The jumper between pins 2 and 3 of the ¼ in key jack was replaced with a jumper with quick-connect pins. In practice, this jumper can be left connected such that the key jack is shorted to ground (vfo keyed) whenever no key is plugged into the jack. So, to use grid-block keying, use the RCS jack (#2 above) and do not plug a key into the ¼ in jack. To use cathode keying, use the ¼ in key jack and do not plug anything into the RCA jack.
4. This unit had a 25uh rf choke in the plate lead. The schematic specifies a 350uh choke and this was a change made by Heath in later units. The 25uh choke seemed to result in low output on some bands and an unusual knee in the output waveform (scope patterns). I didn't have a 350uh choke but replaced the 25uh choke with a 1.1 mh choke. The latter is the cathode choke from a junker HG-10.





Power supply:

The transformer has a 6.3vac secondary and a 140vac secondary. The diodes in the bridge can be any diode with a piv of 300 or so and 500 ma or even a little less. The filter capacitor is 100mfd at 250 v.

The following pages contain reprints of the more significant pages from the HG-10 manual. After that, some information is presented about the plate choke value and the output wave form.

INSTALLATION

This part of the manual is divided into the following three sections to cover the different types of VFO installations:

1. Use with the Heathkit DX-60 series Transmitters or HW-16 Transceiver.
2. Use with the Heathkit DX-40 Transmitter.
3. Use with other transmitters, having suitable VFO input and VFO operating voltage provisions or, having a VFO input but no provisions for furnishing operating voltages to the VFO.

Use only the section which applies to your particular installation of the VFO.

HEATHKIT DX-60 SERIES OR HW-16

Connect the octal plug of the VFO power cable to the accessory socket of the transmitter, and connect the prepared coaxial cable from the VFO output socket to the transmitter's VFO INPUT. Be sure to turn the front panel XTAL switch to VFO and turn the DRIVE LEVEL control to "0" while checking VFO calibration.

Now proceed to the VFO Calibration section of the manual.

HEATHKIT DX-40

It is necessary to make three simple circuit changes in the VFO in order to use it with the DX-40 Transmitter. Make these changes as follows:

( ) Locate the resistor connected to lug 4 of the accessory socket in the DX-40. Replace this resistor with a 10 KΩ 10 watt resistor, obtained locally.

( ) Disconnect the green wire of the power cable from lug 2 of terminal strip A, then reconnect this wire to lug 3 of terminal strip A. See Figure 1.

( ) Clip out the bare wire connected between lugs 2 and 3 of the KEY jack. See Figure 1.

The VFO is now ready for use with the DX-40 Transmitter. Connect the octal plug of the VFO power cable to the accessory socket of the DX-40. Connect the prepared coax cable from the VFO output socket to the VFO input of the DX-40.

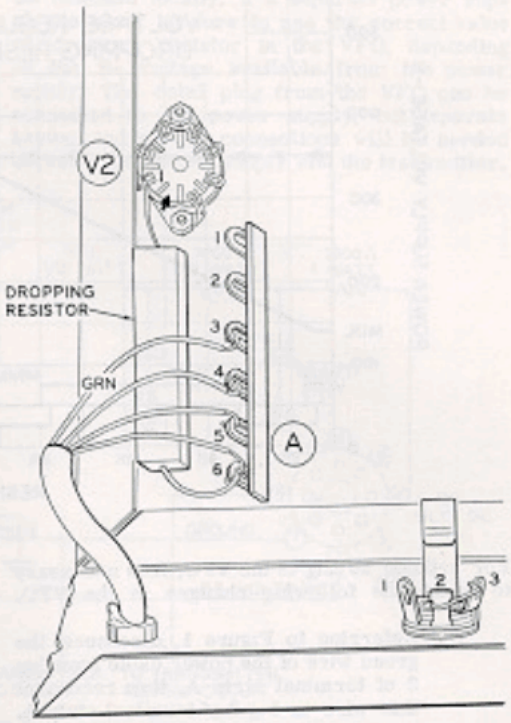


Figure 1

Proceed to VFO Calibration section of the manual.

OTHER TRANSMITTERS

Depending on your particular transmitter, it may be necessary to make one or more circuit changes in the VFO. These possible circuit changes concern "Keying" and "Supply Voltage." Each of the items should be handled separately, as follows:

KEYING

If your transmitter provides a grid block keying signal (-65 volts or more) it will not be necessary to change the VFO keying circuit. The grid block keying signal is applied to the VFO through the green wire of the power cable, which is connected to pin 8 of the octal plug.

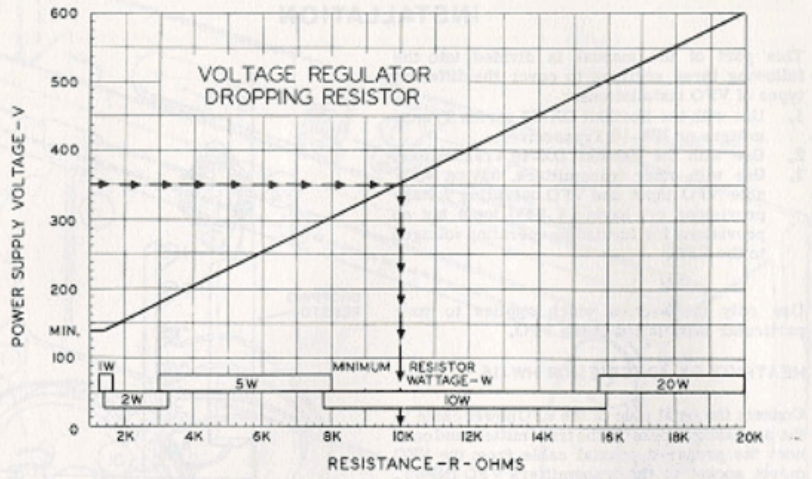


Figure 2

For cathode keying of the VFO, it is necessary to make the following changes in the VFO.

( ) Referring to Figure 1, disconnect the green wire of the power cable from lug 2 of terminal strip A, then reconnect this wire to lug 3 of terminal strip A.

( ) Clip out the bare wire connected between lugs 2 and 3 of the KEY jack if the key is to be plugged into the transmitter.

The VFO is now ready for cathode keying. The key may be connected to the VFO KEY jack or to the transmitter. If the key is connected to the transmitter, the keying connection to the VFO is made through pin 8 and the green wire of the VFO power cable.

SUPPLY VOLTAGE

The value of the B+ voltage applied to the voltage regulator tube in the VFO is critical. For this reason, the value of the Dropping Resistor in series with the VR tube must be chosen to provide the correct voltage. The chart in Figure 2 should be used to determine the correct resistance and wattage of the Dropping Resistor. For example: If the B+ available from the transmitter is 350 volts, draw a line from the 350 volt point on the vertical scale across to the diagonal line of the graph. Then draw a line down from the point of intersection, to the horizontal scale. The point at which this line crosses the horizontal scale indicates the resistance value and wattage for the Dropping Resistor. This example is shown by the line of arrows on Figure 2. Do not use smaller resistance or wattage values. The correct Dropping Resistor should be installed in the VFO as shown in Figure 1. The 10 KΩ, 10 watt resistor, already in the VFO, should be removed. Figure 3 shows the VR tube and Dropping Resistor circuit schematically.

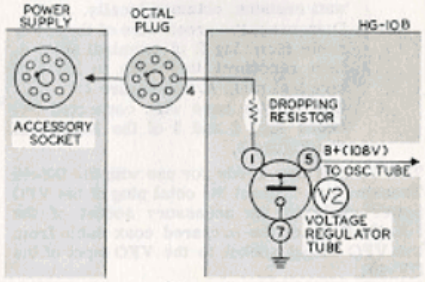


Figure 3

Filament voltage of 6.3 volts AC should be applied to the VFO through pin 2 of the octal plug and the white wire of the power cable. Pin 1 and the black wire are used for the ground connection between the VFO and the transmitter.

If your transmitter cannot be used to supply operating voltages to the VFO, you may choose to build a separate power supply for the VFO.

The circuit of a suitable power supply is s in Figure 4. Parts for the power supply sh be obtained locally. If a separate power ply is used, be sure to use the correct of dropping resistor in the VFO, depe on the B+ voltage available from the p supply. The octal plug from the VFO ca connected to the power supply, but sepa keying and ground connections will be ne between the power supply and the transmi

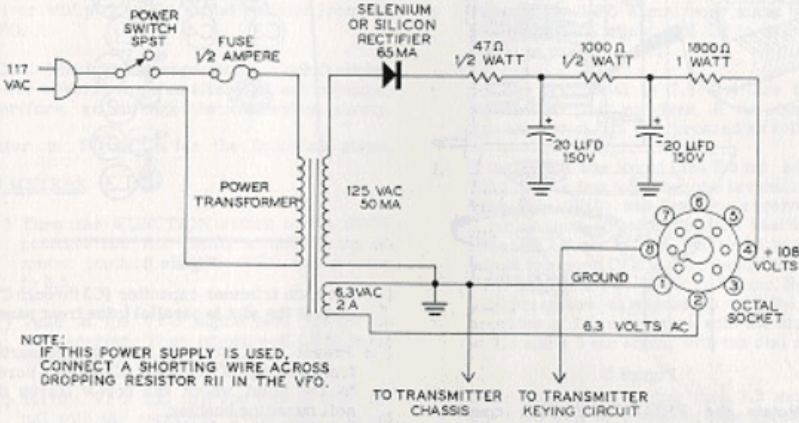


Figure 4

VFO CALIBRATION

DIAL INDICATOR

(✓) Loosen the 6-32 screw that is used as a setscrew in the bushing of the dial cylinder. Next, set the BAND switch to the 80 meter position, then position the dial cylinder so that the 80 meter scale is centered, looking through the dial window from the front of the VFO. Tighten the setscrew in the dial indicator bushing.

(✓) Rotate the BAND switch through its positions. In each position, the corresponding dial scale should be centered, looking through the dial window. If the scales are not centered in the dial window opening, repeat the preceding step.

DIAL POINTER

(✓) With the BAND switch in the 80 meter sition, rotate the FREQUENCY knob cl wise until you feel the mechanism r the upper mechanical stop.

(✓) Position the dial pointer 1/16" to the rig 4.0 on the scale, then secure the pointe the dial cord by bending the fingers o pointer. Be careful not to cut the cord.

(✓) Rotate the FREQUENCY knob coun clockwise and see that the dial poi travels smoothly.

HG1

Filament voltage of 6.3 volts AC should be applied to the VFO through pin 2 of the octal plug and the white wire of the power cable. Pin 1 and the black wire are used for the ground connection between the VFO and the transmitter.

If your transmitter cannot be used to supply operating voltages to the VFO, you may choose to build a separate power supply for the VFO.

The circuit of a suitable power supply is shown in Figure 4. Parts for the power supply should be obtained locally. If a separate power supply is used, be sure to use the correct value of dropping resistor in the VFO, depending on the B+ voltage available from the power supply. The octal plug from the VFO can be connected to the power supply, but separate keying and ground connections will be needed between the power supply and the transmitter.

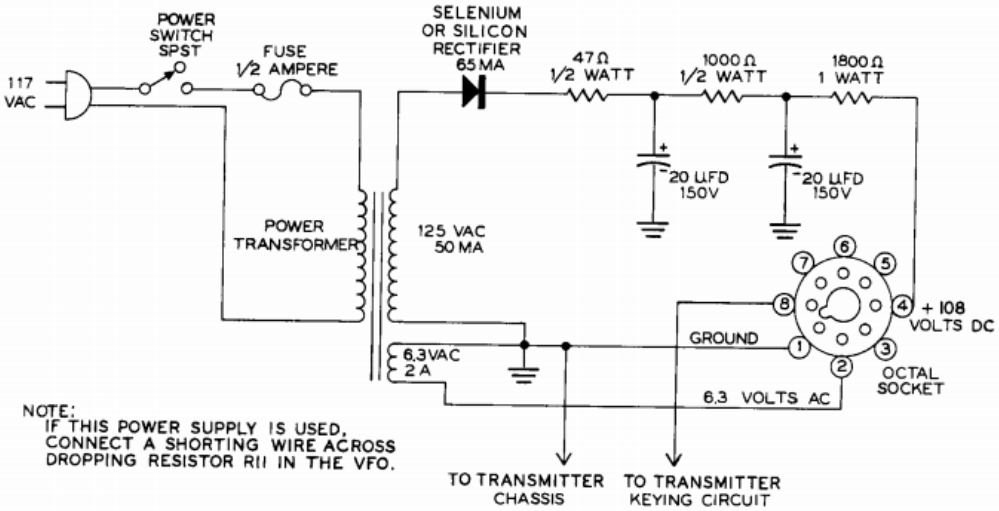


Figure 4

VFO CALIBRATION

DIAL INDICATOR

(✓) Loosen the 6-32 screw that is used as a setscrew in the bushing of the dial cylinder. Next, set the BAND switch to the 80 meter position, then position the dial cylinder so that the 80 meter scale is centered, looking through the dial window from the front of the VFO. Tighten the setscrew in the dial indicator bushing.

(✓) Rotate the BAND switch through its positions. In each position, the corresponding dial scale should be centered, looking through the dial window. If the scales are not centered in the dial window opening, repeat the preceding step.

DIAL POINTER

(✓) With the BAND switch in the 80 meter position, rotate the FREQUENCY knob clockwise until you feel the mechanism reach the upper mechanical stop.

(✓) Position the dial pointer 1/16" to the right of 4.0 on the scale, then secure the pointer on the dial cord by bending the fingers of the pointer. Be careful not to cut the dial cord.

(✓) Rotate the FREQUENCY knob counterclockwise and see that the dial pointer travels smoothly.

VARIABLE CAPACITOR

(✓) Loosen the setscrew in the small brass gear of the variable capacitor assembly. Refer to Figure 5.

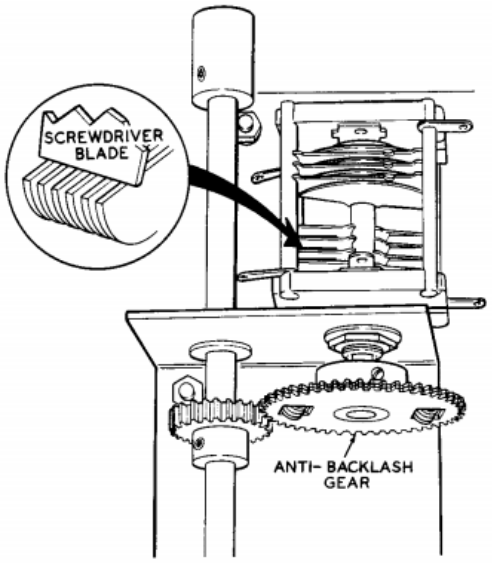


Figure 5

(✓) Rotate the FREQUENCY knob counter-clockwise until you feel the mechanism reach the lower mechanical stop. NOTE: This stop is spring loaded and the shaft will slip if the FREQUENCY knob is turned farther.

(✓) While holding the FREQUENCY knob at the lower mechanical limit, turn the anti-backlash gear by hand until the plates of the variable capacitor are meshed. The plates are properly meshed when the edges are flush at the point shown in Figure 5. The end of a screwdriver blade can be used to check for proper mesh at this point. Retighten the setscrew in the small brass gear.

(✓) The VFO bottom plate should be installed now, using eleven #6 x 1/4" sheet metal screws. See Pictorial 10 on Page 26.

PRESET ADJUSTMENTS

Refer to Figure 6 for the following steps.

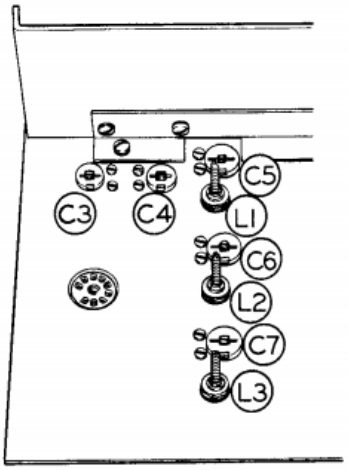


Figure 6

(✓) Set each trimmer capacitor (C3 through C7) so that the slot is parallel to the front panel.

(✓) Preset each coil as follows, measuring from the tip of the coil adjustment screw to the point where the screw leaves the coil mounting bushing.

COIL	DIMENSION
L1	1"
L2	7/8"
L3	7/8"

TRIMMER COIL ADJUSTMENTS

To calibrate the VFO, it will be necessary to use an accurate radio receiver that covers 3.5 to 9 megacycles. For best results, use a crystal calibrator with the receiver to assure setting the receiver dial to the exact frequencies called for. The VFO adjustments should be made with an insulated alignment tool.

Before proceeding with calibration, install the two tubes in the VFO: V1 = 6CH8, V2 = OB2.

After the tubes are installed, take care not to damage the tubes by setting the VFO upside down. Connect the power cable of the VFO to your transmitter as directed in the Installation section of the manual; then turn on both units and allow the VFO to warm up for at least thirty minutes. The coax cable need not be connected between the VFO and transmitter during calibration.

When making the following adjustments, the VFO should be placed next to the receiver so the receiver will pick up the signal radiated from the VFO.

NOTE: The trimmer capacitors may drift slightly for several minutes after they are adjusted, therefore, go through the calibration slowly.

Refer to Figure 6 for the following steps.

80 METERS

( ) Turn the FUNCTION switch to the SPOT position and the BAND switch to the 80 meter position. Set the VFO dial pointer to 3.5.

( ) Tune in the VFO signal near 3.5 mc on the receiver. Then adjust coil L3 to bring the signal to exactly 3.5 mc.

( ) Set the VFO dial to 4 and tune in this signal with the receiver. If the signal is not exactly at 4 mc, proceed as follows:

1. If the signal is lower than 4 mc, set the VFO dial a few kc above the bottom of the band (try 3510) and turn the receiver to 3.5 mc. Adjust coil L3 for zero beat in the receiver. Next, set the VFO dial to 3.5 and adjust trimmer C7 for zero beat. Check the VFO against the receiver at 4 mc. Repeat this procedure as necessary until the VFO provides a 4 mc signal with the dial set at 4 and a 3.5 mc signal with the dial set at 3.5.

2. If the signal was higher than 4 mc, set the VFO dial to 3.5 and turn the receiver a few kc above the bottom of the band (try 3510). Adjust coil L3 for zero beat in the receiver. Turn the receiver to 3.5 mc and adjust trimmer C7 for zero beat. Check the VFO against the receiver at 4 mc. Repeat this procedure until the VFO provides a 4 mc signal with the dial set at 4 and a 3.5 mc signal with the dial set at 3.5.

40-20-15-10 METERS

( ) Leave the FUNCTION switch in the SPOT position and turn the BAND switch to the 40 meter position. Set the VFO dial pointer to 7.

( ) Tune in the VFO signal near 7 mc on the receiver, then adjust coil L2 to bring the signal to exactly 7 mc.

( ) Set the VFO dial to 7.3 and tune in the signal with your receiver. If the signal is not exactly at 7.3 mc, proceed as follows:

1. If the signal was lower than 7.3 mc, set the VFO dial a few kc above the bottom of the band (try 7010) and turn the receiver to 7 mc. Adjust coil L2 for zero beat in the receiver. Next, set the VFO dial to 7 and adjust trimmer C6 for zero beat. Check the VFO against the receiver at 7.3 mc. Repeat this procedure as necessary until the VFO provides a 7.3 mc signal with the dial set at 7.3 and a 7 mc signal with the dial set at 7.

2. If the signal was higher than 7.3 mc, set the VFO dial to 7 and turn the receiver a few kc above the bottom of the band (try 7010). Adjust coil L2 for zero beat in the receiver. Turn the receiver to 7 mc and adjust trimmer C6 for zero beat. Check the VFO against the receiver at 7.3 mc. Repeat the procedure until the VFO provides a 7.3 mc signal with the dial set at 7.3 and a 7 mc signal with the dial set at 7.

The above adjustments cover the 20, 15, and 10 meter bands as well as the 40 meter band since all of these bands use multiples of the 7 mc band signals.

6 METERS

Leave the FUNCTION switch in the SPOT position and set the BAND switch to the 6 meter position. Set the VFO dial pointer to 50.4.

( ) Tune in the VFO signal near 8.4 mc on the receiver, then adjust coil L1 to bring the signal to exactly 8.4 mc as tuned on the receiver.

( ) Set the VFO dial to 54 and tune in this signal near 9 mc with your receiver. If the signal is not exactly at 9 mc, proceed as follows:

1. If the signal was lower than 9 mc, set the VFO dial a few kc above 50.4 and turn the receiver to 8.4 mc. Adjust coil L1 for zero beat in the receiver. Next, set the VFO dial to 50.4 and adjust trimmer C5 for zero beat. Check the VFO setting at 54 against the receiver at 9 mc. Repeat this procedure as necessary until the VFO provides a 9 mc signal with the dial set at 54 and an 8.4 mc signal with the dial set at 50.4.

2. If the signal was higher than 9 mc, set the VFO dial to 50.4 and turn the receiver a few kc above 8.4 mc. Adjust coil L1 for zero beat in the receiver. Turn the receiver to 8.4 mc and adjust trimmer C5 for zero beat. Check the VFO setting at 54 against the receiver at 9 mc. Repeat this procedure until the VFO provides a 9 mc signal with the dial set at 54 and an 8.4 mc signal with the dial set at 50.4.

NOTE: If an 8.33 to 9 mc receiver is not available, a 6 meter receiver can be used, aligning at 50 and 54 mc.

2 METERS

( ) Leave the FUNCTION switch in the SPOT position and set the BAND switch to the 2 meter position. Set the VFO dial pointer to 144.

( ) Tune in the VFO signal near 8 mc on the receiver. Adjust trimmer C3 until the signal is exactly 8 mc. Then set the VFO dial to 147.6 and tune in this signal near 8.2 mc on the receiver. Adjust trimmer C4 for a signal at exactly 8.2 mc.

( ) Repeat the above two adjustments until an output signal of 8 mc is obtained with the VFO dial set at 144 and a signal of 8.2 mc is obtained with the VFO dial set at 147.6.

NOTE: A 2 meter receiver can be used if an 8-8.222 receiver is not available, using 144 and 148 mc as alignment points.

( ) Recheck the 6 and 2 meter calibration for accuracy.

This completes the calibration of your VFO. Install the cabinet with the screws shown in Pictorial 10 on Page 26.

NOTE: It will be noted that bands 40, 20, 15, and 10 do not have their calibrations in exact alignment with each other. This is due to the slight changes in lead length in the band switch between bands, and causes no harm.

OPERATION

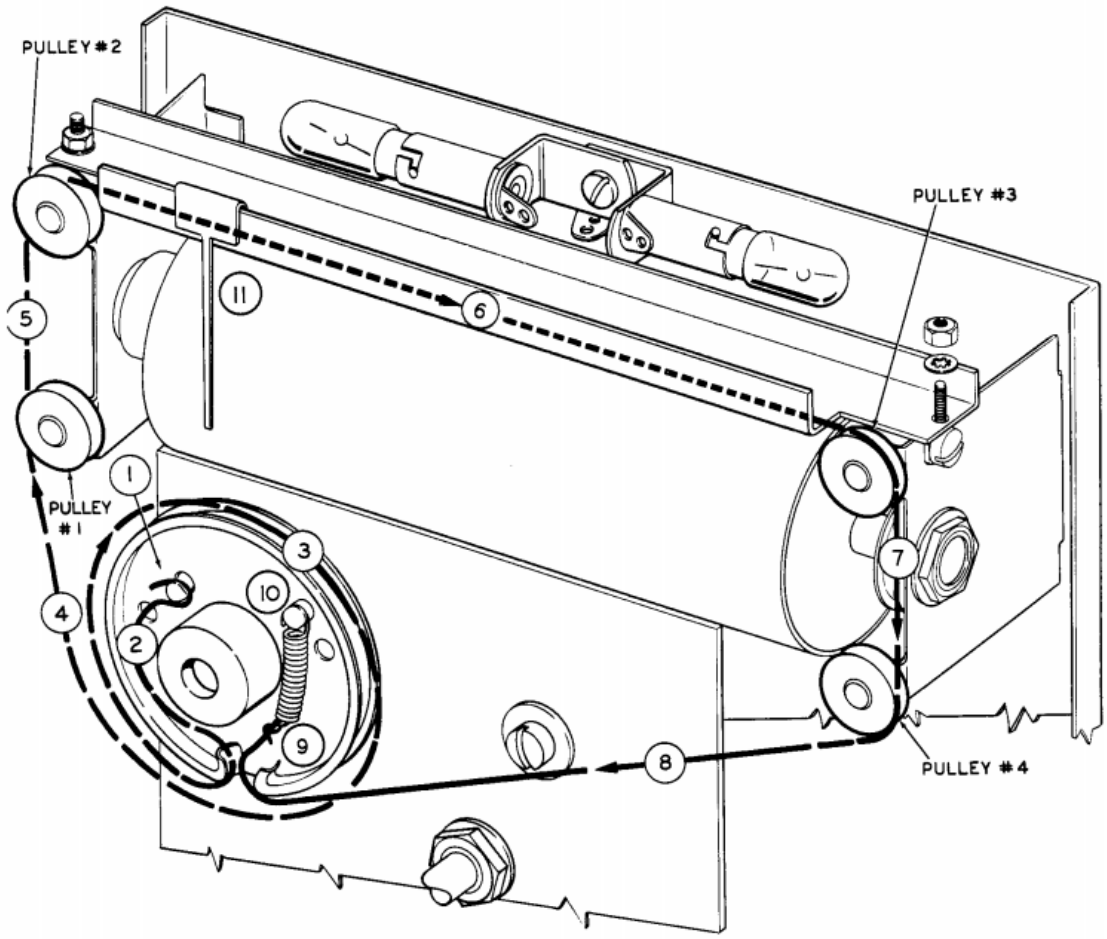
By means of the FUNCTION switch, the VFO may be controlled independently of the transmitter or controlled by the transmitter. With the key up, the VFO should be operated alone for tuning purposes by turning to SPOT. It is bad operating procedure to tune a VFO across the band with the entire transmitter 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 frequency. This procedure produces far less interference.

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 sideband transmitter can put some hash on the undesired sideband and create signals outside of the amateur band.

Refer to the operating directions for your transmitter which concern use of the transmitter with a VFO.

NOTE: The VFO may be keyed any time by using a key in its key jack, provided proper voltages are supplied to it. This feature is useful for testing keyers or for code practice, and for use with transmitters which will work when just the VFO input is keyed.

NOTE: The transmitter FUNCTION SWITCH must be in the TUNE position when using the VFO in SPOT in order to supply B+ voltage to the VFO.



Pictorial 8

Above is a shot of the back of the VFO showing the original RF Output socket on the left, followed by the added power transformer, grid-block key jack, on-off switch, fuse, and power cord. The power cord uses the hole previously occupied by the power input cable. There is nothing critical about this arrangement; however, it is probably a good idea to uses grommets for the transformer connections.

Notice two things from the above test. First, the vfo dial is set at 7.2 and the frequency meter shows that it is pretty close. Second, note the scope pattern with the unusual knee. This pattern is with the original 25uh rf choke in the plate lead. This value was changed to 350uh by Heath later. The much cleaner pattern below shows the results after changing the 25uh choke to a 1.1mh choke. The latter is the cathode choke from a junker HG-10.