Cavity band change, by Karl Shoemaker

Introduction

This document explains the procedure for band changing a cavity from the amateur 2-meter band to the amateur 1.25-meter band.

A RF cavity is a filter device normally tuned to specific frequency for the propose of RF management; in most cases control of RF interference. Several cavities with a coaxial "harness" make up a duplexer. For this discussion will be focused on just a single cavity.

Cavities come in various physical sizes but can be made electrically for the same band. Also, they are made in the different RF bands for both commercial and amateur use. In many cases used commercial band cavities can be tuned for the amateur band. It depends on the cavity design, specifications and "Q" of these devices.

Shown here is the stock device, in the form of a "tube" or "bottle" being a cylinder with a length of 24" on the outside. Inside consists of a resonant "stub" and a coupling loop. The latter is to couple the cavity's function electrically to a transmission line, normally called "coax" for short. All lengths for the cavity's components and the coax line(s) are important for proper operation. For this discussion the Author is using a Sinclair (brand) VHF "hi-band" cavity designed for the 144 ~ 174 MHz band.

We will cover standard tuning on the original band this cavity is designed to work. This will verify the (used) stock cavity is working properly before modification. Later, the band change will be covered.

This type of cavity is a “BpBr”, meaning, band pass / band reject.

Starting from the top is the tuning rod that moves the piston inside the internal stub (shown later). For a course adjustment you loosen the set screw on the side of the nut and move it up or down. Once you are close tighten the screw carefully as not to break it off.

The tuning mount does not move for the tuning procedure. It’s only to mount the other components just described. The set screw on the mount is to secure the nut/rod upon tuning completion. It’s not needed in many cases to use this screw. It’s only there to prevent possible movement during transport and to discourage benign tampering by unauthorized (curious) “hams” at the site.

Both the nut and set screws are right handed threaded. That means to decrease the frequency you turn the tuning nut CW to cause the rod to go down inside the cavity to lengthen it. As a reminder, lower frequency is longer wavelength even in the case of most cavity tuning.

To tune this device you need to decide how much “Q” you need. Meaning, the quality of the circuit. A “tight” curve will produce higher performance. This is controlled by the position of the coupling loop.

You don’t get a “free lunch”. The higher “Q” setting results in more RF loss through the device. Therefore, it’s a balance between cavity performance and loss. Some cavity brands have the loop marked on the top such as “.5, 1.0” etc. This indicates the loss factor in db.

The Bell scale is the best way to make all RF measurements. Site / station management is beyond the scope of this document however, there are other documents on the SRG web site to address these subjects.

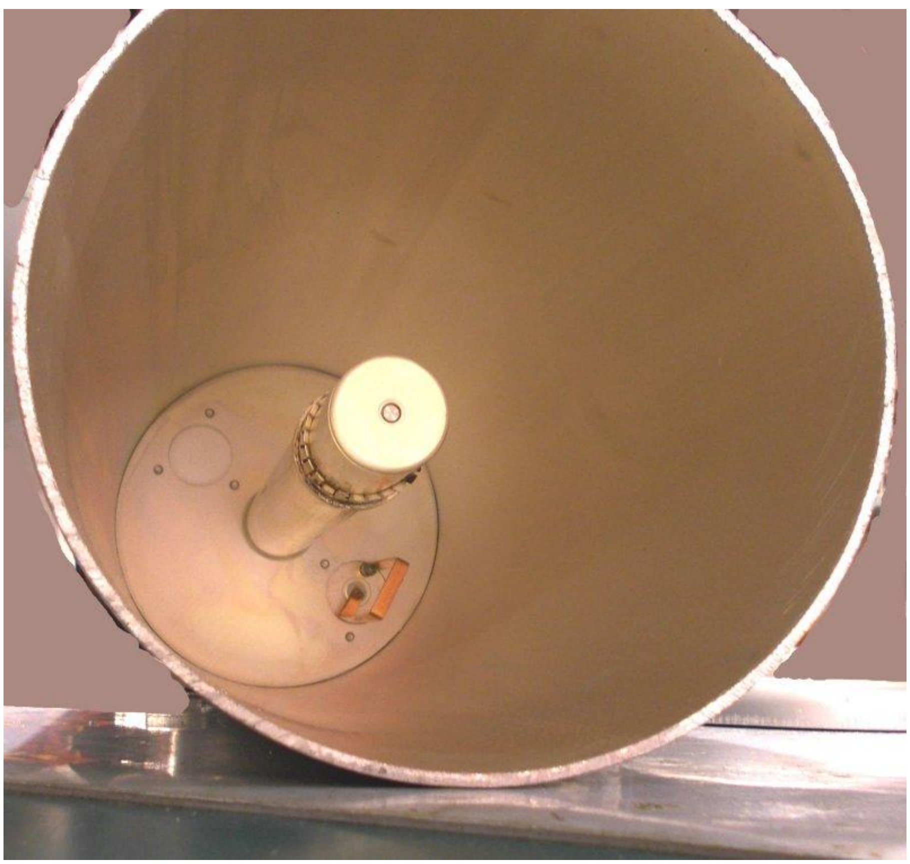
Once you decide on the “Q” and frequency you need to start with connecting a signal generator to one side of the “t” and a spectrum analyzer on the other. A tracking generator is the easiest way to tune however, most hams don’t have that type of budget or justification in their inventory. The latter is normally used with commercial radio shops, which charge for this service.

Next, peak the output as observed on the analyzer with the tuning nut. Then move the frequency you wish to notch and tune the capacitor for a minimum level as observed on the spectrum analyzer.

For this type of cavity you should get about 1 db of insertion loss at the pass frequency and 35 db of notch at the other; again, depending where you set the coupling loop for the Q factor.

For the band change the cavity is disassembled with the basic components of the cavity itself, the stub and tuning rod. For simplicity the RF port / coupling loop / tuning cap was left attached to the cavity. That’s optional.

Cut the cavity (tube) from the stock 24” to 16 ½ “. Cut the stub to 10”. Later, when you temporarily assemble these components move the rod down to the bottom of the cavity (lowest frequency possible) and cut the rod to still protrude out the top of the tuning nut about 2” for easy grasping it for tuning on the final frequency.



Shown here is a close-up of the stub, piston and coupling loop after the cutting is done.

You can see the coupling loop is at maximum, which is considered “critical coupling, producing the highest Q but also the highest insertion loss.

The “finger stock” is what makes the contact between the stub and tuning piston. This will need to be removed and re-soldered on the new stub length

Shown here is the leftover cavity and stub materials. As you can see the Author performed 2 cuts to be sure the correct frequency spread was obtained. In addition, the Author assembled the cavity enough to verify correct tuning range was realized. The reason is you don't want to over-cut and make the parts too short and useless.

For these dimensions gives the cavity a practical range 185 ~ 255 although the extreme edges showed reduced cavity performance. They are not needed therefore, is a moot point. This puts the 1.25-meter amateur band right in the middle of the tuning range, which is the goal.

Shown here is the final "product" modified for the amateur band. Shown here in the "high" mode, AKA high pass mode with the 1/4 wavelength of coax "T" connected to the cavity's RF port (connector). For the low pass mode one just leaves this T extension out.

Also the application calls for the (sub-grade) "UHF" connectors therefore, an adapter was needed. For ideal installations should use type N connectors throughout the station as is a common practice for commercial and quality installations.