Duplexer Basics

Cavity filters can be used as narrow BandPass filters, a single tuned circuit with a very high Q (12000+) coupled into and out of by various methods, usually a loop coupling to the, in cavity magnetic field.
They can also be a narrow BandReject filter, usually done with one coupling loop and where the cavity, at resonance, presents a very low impedance. Thus is used to "short out" the signal on the coax line at a Tee junction.
Because our Ham Radio repeater split frequencies are so narrow, particularly on 6m and 2m, we need a different cavity type, the BandPass AND BandRegect type (BP-BR).

There are SIX main types of BP-BR Cavity filters.

1) The single connector series loop and trimmer to GND type.

2) The two connector, couple a bit of energy between the coupling loops
with either L or C.

3) The two connector, couple some energy magnetically between loops.

4) The two connector, parallel resonant circuit between connectors.

5) The single connector capacitor divider, with either L or C in the GND side.
As in the 2" heliax duplexer for 6m.

6) The two connector, capacitively coupled at the 'hot' end.

AND, the aperture coupled Band Pass UHF cavities as in the image Ant_T_IMG_3734b.jpg below.

AND, the Hybrid Ring, perhaps lost in time as it is for a small frequency range only. Sinclair-F-Series-Hybrid-Ring-Duplexer.pdf circa. 1966

Examples:

Type 1 *Series coil and cap, trimmer to GND*


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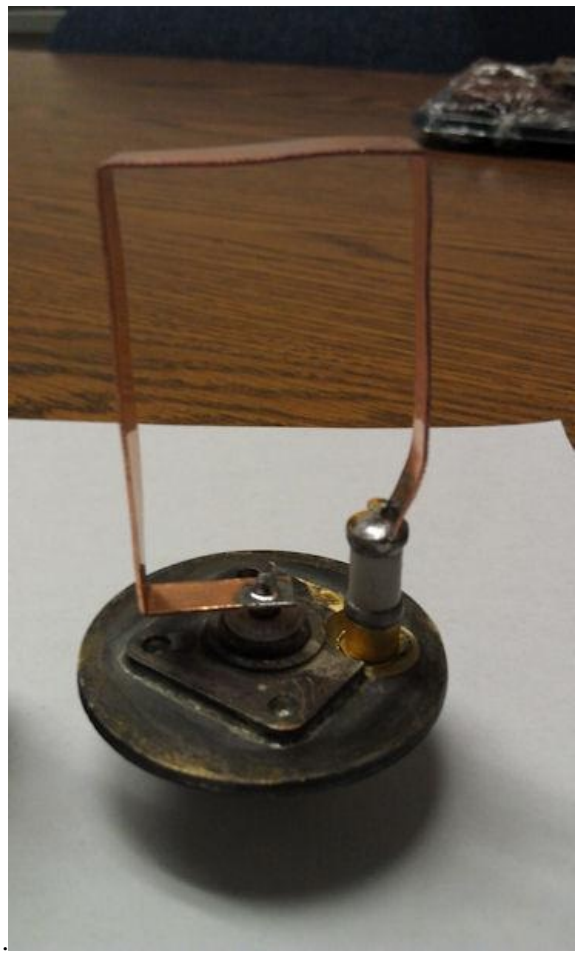
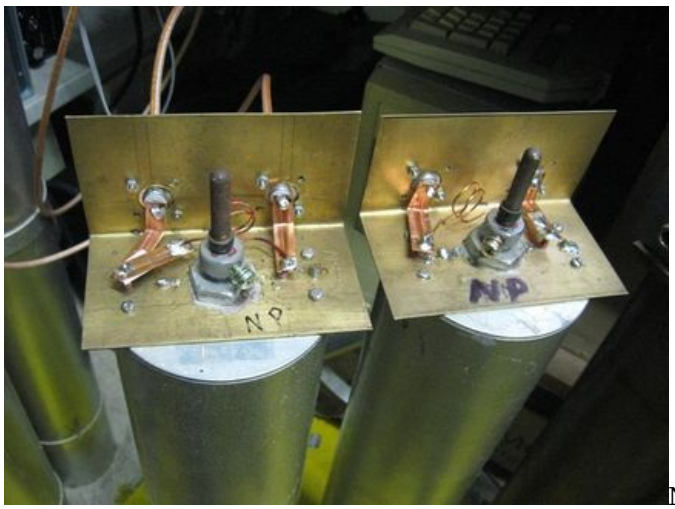


Note: No connectors, hardwired and Gold trimmer.

Type 2 *Couple a bit of signal between loops, L or C*

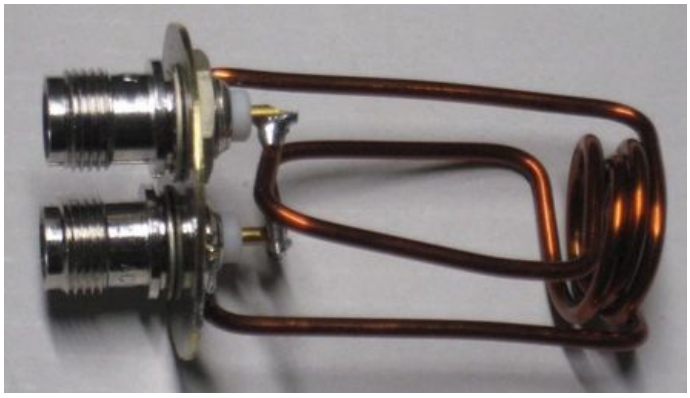


Note phase swap of LHS loop, makes for larger L.

Type 3 *Magnetic coupling*


Magnetic coupling.

Pass then Notch, wire 2x 195mm


Notch then Pass, 2 wires 2mm x 205mm Coil ID 14mm.

Type 4 *Parallel resonant circuit metween two connectors*

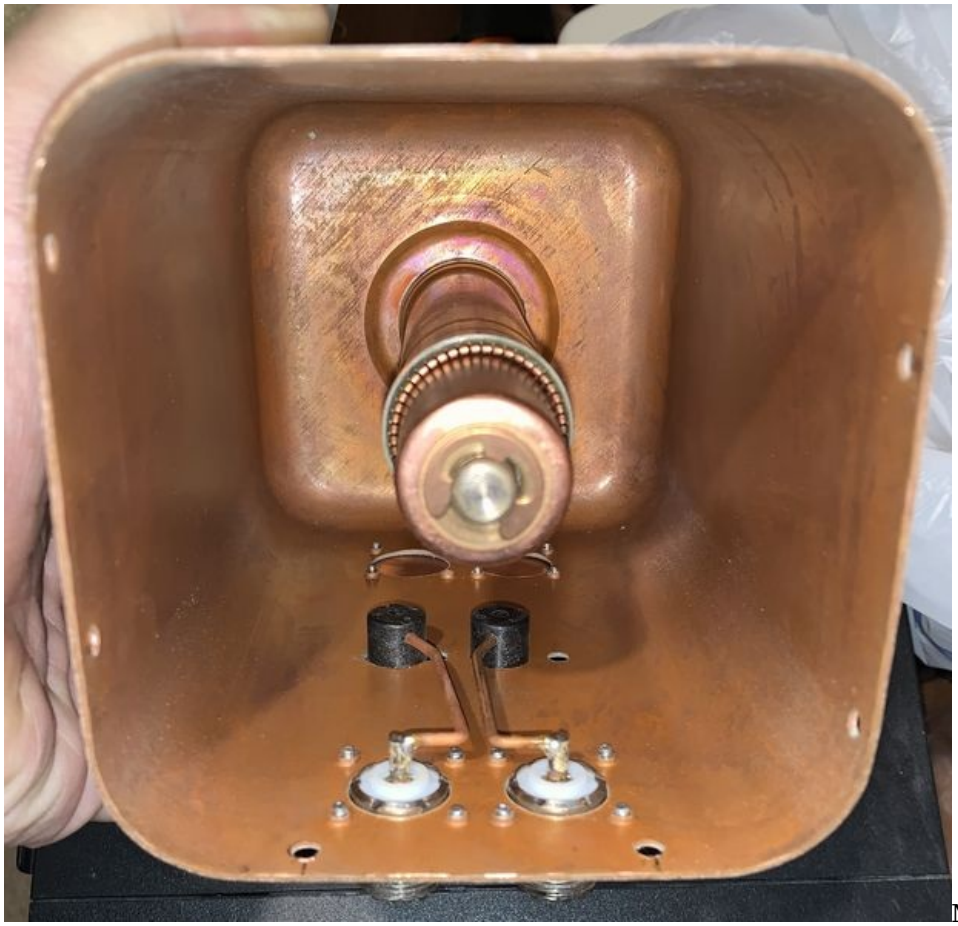
 Two connectors parallel resonant circuit between.
Three adjustments, cavity plunger, rotate probe assy., adjust cap. Requires a large aperture into the cavity.
These are really, the best!!

Type 5, *Capacitive coupling at the Hi Voltage end*

 6m duplexer made with 2" heliax. Inductor to GND.

See A 1972 article on 2" heliax as resonators for 6m

Type 6, *Two connector, Capacitive Coupling at the Hi Voltage end*


Motorola T1500 UHF

An example Combiner, two VHF transmitters 3 MHz apart


Note the caps between the connectors.

Inter cavity cable lengths.

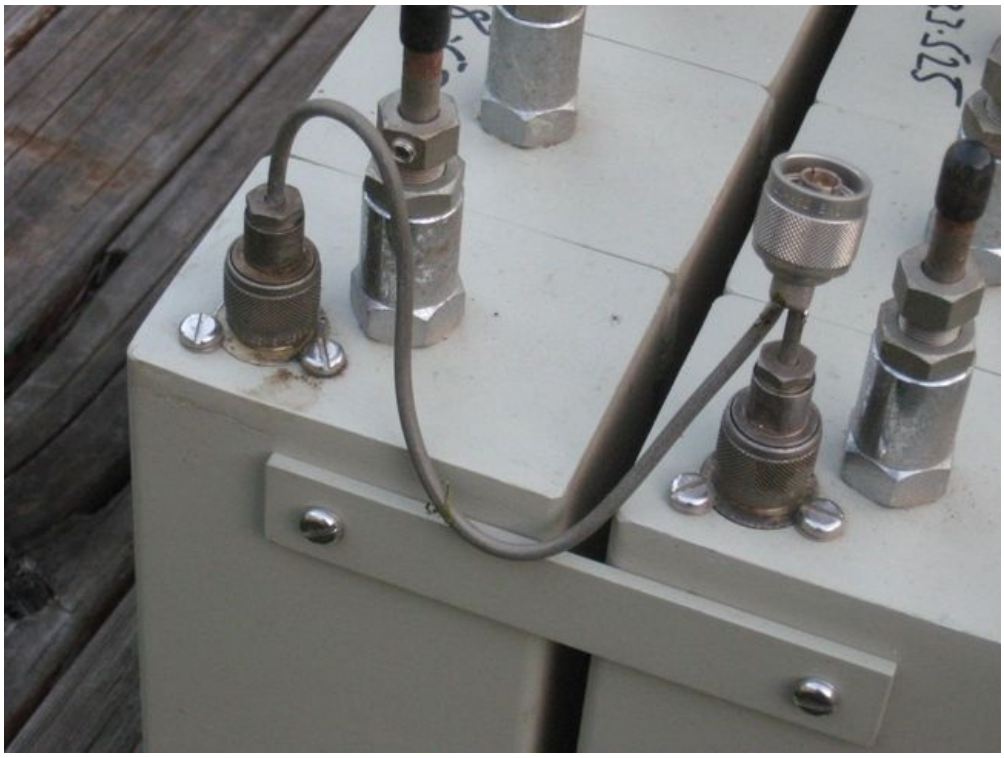
The Antenna Tee Where the two cavity chains join to feed one antenna.

At the notch frequency, types 1 and 5 (above) present a Very Low impedance thus back at the antenna "T" where we need a High impedance as the energy at this frequency is to go straight past, we can use a quarter wavelength line to achieve this.

Type 4 presents a High impedance at the notch frequency so half wave lines are used to the Antenna "T". Between cavity lines, see Ref (h).

Types 2, 3 and 6, at the Reject Frequency present a High VSWR but neither High or Low impedance exactly, this is where it gets hard. A Vector Network Analyser is a great tool here. I doubt they had one back in the 1960s. Instead, General Radio Inc. made a constant impedance adjustable line, is 60cm long and adjusts 20cm and they would have used other known

lengths of coax to calibrate it.



The LHS of my picture Ant_Tee_IMG_3734b.jpg has an extra half wave of hard-line to get the lengths right (as best I could).

Between cavity lines

Type 1 (Series to GND) are easy, 1/4 wave. Others can cause interaction between the cavities such as Type 4.
A Vector Network Analyser should be used at this point. But, can we get away without one with our choice of cavity type.
The BIG question.

So, now you know why some of the coax lengths are not quite quarter wave or half wave. Particularly where the Rx and Tx chains join, the Antenna T.

Examples, home brew:

Some examples of home-made (type 4) coupling loops for 6" RFS or AEA cavities.

IMG_3733b.jpg TNC connectors

Note the coil. I "filsched" this idea from Repeater Builder, "Coupling Loop Research", where they increased the loop inductance with a coil not in the "main" cavity magnetic field. I found this made the pass-to-notch spacing, much easier to adjust. Adjustment by rotating the assy.

2018, Surplus, this is what we get, an ex. 70cm 3/4 wave cavity set.
No inter-connect cables, just the bare cans, ready for 2m conversion.

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