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QST Issue: Dec 1968
Title: Combine VHF Bandpass Filters
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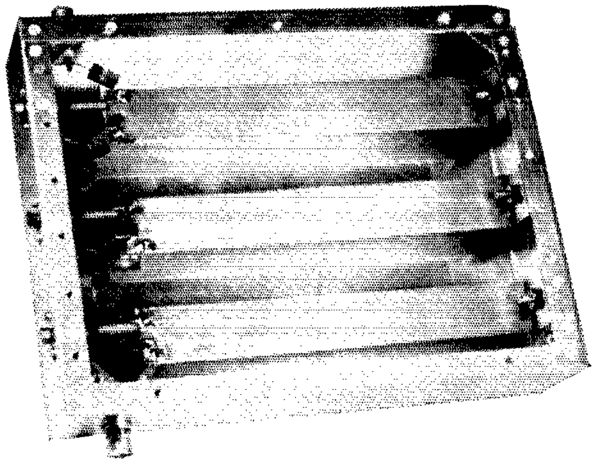
Combline V.H.F. Bandpass Filters

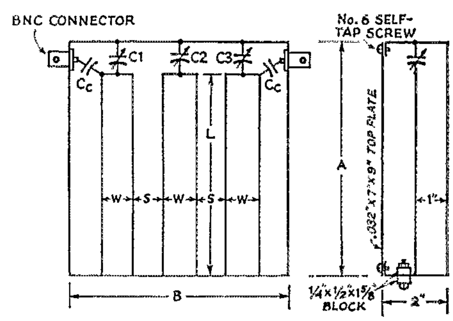


Interior of the 50-MHz. combline filter.

BY REED E. FISHER,* W2CQH

In a previous article[1] it was shown how low-loss multiple-section interdigital bandpass filters could be constructed for 432 and 1296 MHz. These filters are very practical at u.h.f., but when scaled up in size to work on 50 or 144 MHz. they become unwieldy. Interdigital filter theory requires that all the resonators must remain physically a quarter-wave long. Therefore, to reduce the size of v.h.f. filters it is desirable to shorten the resonator lengths by capacitive loading. Cristal[2] has recently shown how this is accomplished in a straightforward manner that yields a combline structure which is exceedingly simple to build, using stripline techniques. The shortened filter is called "combline" because, in contrast to the interdigital structure, all resonators are grounded at the same end of the cavity, simulating teeth of a comb. Although Tilton[3] has already written an excellent article describing the construction and use of stripline and coaxial filters, they are single-section types that do not yield the passband flatness and out-of-band rejection obtainable with multiple-section structures.

Construction details of three-section combline filters centered near 52, 146 and 222 MHz. are given in Fig. 1. Each filter is built in a



DIMENSION	52 MHz.	146 MHz.	222 MHz.
A	9"	7"	7"
B	7"	9"	9"
L	7 3/8"	6"	6"
S	1"	1 1/16"	1 3/8"
W	1"	1 5/8"	1 5/8"
CAPACITANCE (pf.)			
C1	110	22	12
C2	135	30	15
C3	110	22	12
C_C	35	6.5	2.8

Fig. 1—Schematic diagram and principal structural details for combline v.h.f. filters.

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[1] R. E. Fisher, "Interdigital Bandpass Filters for Amateur V.H.F./U.H.F. Applications," March, 1968, *QST*, p. 32.

[2] E. G. Cristal, "Capacity Coupling Shortens Combline Filters," *Microwaves*, Dec. 1967, p. 44.

[3] E. P. Tilton, "Coaxial-Tank V.H.F. Filters," *QST*, Oct. 1964, p. 11.

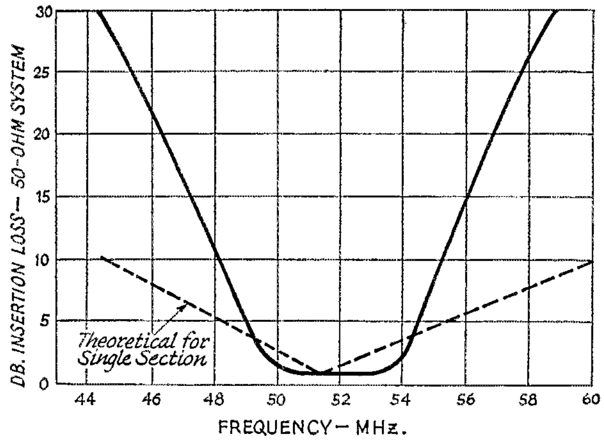

Fig. 2—Bandpass characteristics of the 50-MHz. combline filter, compared with those of a single-section filter.

standard 7 x 9 x 2-inch aluminum chassis (Bud AC-406). The three resonators are made of 0.032-inch flashing copper and spaced one inch from the chassis bottom. Each resonator is firmly clamped to a chassis sidewall by two ¼ x ½ x 1⅝-inch brass blocks. Alternate clamping methods may be tried, but the joints must be secure since large r.f. currents flow in this region, and the best possible electrical connection is mandatory. The tuning capacitors C_1, C_2, and C_3 are APC air trimmers, paralleled, when necessary, with mica capacitors. The coupling capacitors, C_4, are fixed micas or ceramic trimmers. Note that there are no coupling capacitors between resonators; the necessary coupling is obtained by the electromagnetic fields within the cavity. If the filters are to pass more than about ten watts the mica capacitors should be replaced by equivalent air units having adequate plate spacing.

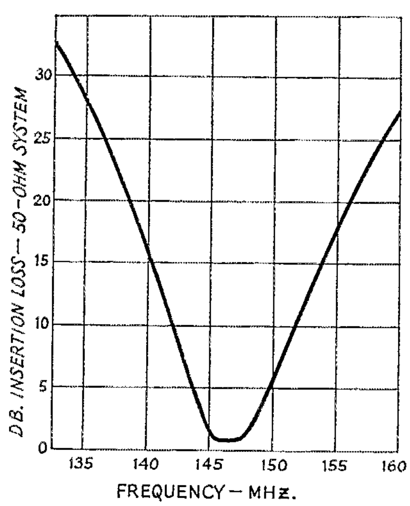

Fig. 3—Characteristics of the 144-MHz. filter.

An aluminum cover, 7 x 9 by 0.032 inches in size, which serves as the top groundplane, is fastened over the chassis opening with No. 6 sheet metal screws. At least six screws should be used in the groundplane edges that face the resonator ends.

The filter can be aligned roughly by individually grid-dipping each resonator with the top cover removed, and with 50-ohm loads attached to each BNC connector. A temporary partial top groundplane, at least double the resonator width, must be clamped over the resonator being dipped, since the cover affects the resonant frequency. Alignment is completed by installing the filter in the system and adjusting all tuning capacitors until maximum signal transmission is obtained at the desired center frequency.

The measured characteristics of the 50-MHz. filter in a 50-ohm system are given in Fig. 2. The filter has a "maximally-flat" response. The 3-db. bandwidth is about 5 MHz., and the mid-band (52 MHz.) insertion loss is 0.6 db. The dotted curve is the theoretical response of a single-section coaxial or stripline filter having the same 3-db. bandwidth. It is evident that the three-section filter gives steeper out-of-band rejection, yet does not have to be retuned when the frequency is moved across the band.

The two-meter filter's measured characteristics are shown in Fig. 3. The 3-db. bandwidth was again about 5 MHz., and the midband (146 MHz.) insertion loss was 0.7 db. The 220-MHz. filter was not constructed but should give a 6-MHz. 3-db. bandwidth and low midband loss.

If the filters are to be used in a 75-ohm system, the coupling capacitor value should be multiplied by $\sqrt{50/75}$=0.082. For example, the new value of coupling capacitors in the six-meter filter would be 0.082 x 36 pf. = 30 pf. All other capacitors and dimensions should remain unchanged.

Hopefully these structures should solve the most knotty v.h.f. filtering problem. QST