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Aids in Filter Designing

By the Engineering Department, Aerovox Corporation

FILTER networks may be built up from reactances in different configurations but this article is confined to the well-known "ladder"-networks of the type shown in Figure 1. The series impedance Z_1 and the shunt impedance Z_2 may consist of inductive reactances or capacitive reactances or several in combination. They may or may not have appreciable resistance.

Such a ladder network can be considered as built up of several sections either of the "T"-type or the "Pi"-type as illustrated in Figure 2. Note that each of the two series arms of the T-section are equal to $Z_{1/2}$, since adding several sections together will put two of these in series, resulting in a full-series impedance Z_1. For a similar reason, the individual Pi-section has shunt arms equal to $2Z_2$, for, when two sections are added together two of these are in parallel and form the full-shunt impedance Z_2.

When a filter ends with half a series-arm it is said to be mid-series terminated. When it ends with the double shunt-arm it is mid-shunt terminated.

The image impedances of a filter are the two impedances, not necessarily alike, which will simultaneously terminate the filter at its two ends so there will be no reflection loss. This occurs when the image impedance is equal to the impedance looking into the filter at that end.

When the two image impedances are equal, the filter is symmetrical, and they are equal to Z_0, the characteristic impedance.

The characteristic impedance and/or the image impedance may be found by measuring the impedance of the filter at one end with the other end left open and again with the other end shorted. The desired impedance equals the geometric mean of the two values obtained.

The image impedance and characteristic impedance generally vary with frequency so the two measurements must be carried out at the same frequency.

CONSTANT-K FILTER

The filters discussed here are of the "constant-k type" which means that the product Z_1Z_2 is constant for all frequencies and equal to k^2. This value k is again equal to the characteristic impedance of the filter over the greater part of the pass band and equal to the value R used in the calculations.

Such a filter, when properly terminated in its image impedance, acts as a resistance load on the generator throughout the pass-band, but, at the cut-off frequency the load becomes either zero or infinite and thereafter it is imaginary. In other words, in the attenuation band the filter acts as a reactive load, does not take any energy from the generator, and does not transmit any energy to its terminating impedance.

Figure 3 shows the hook-up of four types of filters with the equations for their elements while Tables I and II contain tabulations of these values for different cut-off frequencies.

In general it will be necessary to use filters of more than one section if a sharp enough cut-off is to be obtained and these sections need not necessarily be the same. Other sections, having special attenuation characteristics can be "derived" from the filter sections of the "prototype" described here. These will be dealt with in a later article.

USE OF THE TABLES

Table I lists the element values for low-pass and high-pass filters with 500 ohms and 10,000 ohms characteristic impedance. These are the values for the full series arm and the full shunt arm, Z_1 and Z_2 as in Figure 1. They are given in henries and microfarads except in some cases where microhenries and micro-microfarads are used.

The cut-off frequencies listed were selected to minimize the work to be done by the user. All element values are inversely proportional to the cut-off frequency. This information will serve to find data for filters having a cut-off frequency which may not be listed. For instance: A low-pass filter working out of and into a 500 ohm line and having a cut-off frequency of 150 cycles requires a coil of 1.06 henry inductance and a shunt condenser of 4.24 microfarads. For a cut-off frequency of 1500 cycles these values become .106 henry and .424 mfd. When the cut-off frequency is 15 mc. the values become 10.6 microhenry and 42.4 mmfd. Note that the figures remain the same but the decimal point only has been moved. A guide to the placing of the decimal point is found by noting that the required values must be between those for 10 and 30 mc.

When a filter is to be designed for a different characteristic impedance R, find the required data first for a 500 ohm filter. Then multiply the inductance value by R/500 and divide the capacity value by the same factor.

In Table II is listed the required data for a band-pass filter of 500 ohms, having different band-widths and different mid-frequencies, f_m. Usually the two cut-off frequencies for the filter are given. Let us call these f_1 and f_2, f_1 being the smaller one. The mid-frequency is then the geometric mean between the two or $f_m^2 = f_1 f_2$. The band-width, for the purpose of this table is defined as $(f_2 - f_1)/f_m$. So, for instance, a filter with a lower cut-off frequency of 625 cycles and an upper cut-off frequency of 1625 cycles has a mid-frequency of 1000 cycles and a band-width of unity. A filter with the same mid-frequency and a band-width of .2 would have cut-off frequencies of 910 and 1110 cycles.

All values are given in henries and microfarads except those marked "m" which are in microhenries and micromicrofarads.

Similar to Table I, element values for different mid-frequencies and different characteristic impedances can be obtained by interpolation or displacement of the decimal point, remembering that all element values are inversely proportional to the mid-frequency, the inductances are proportional and the capacities inversely proportional to the characteristic impedance.

When a different band-width is desired, the element values are found from the following rule: L_2 and C_1 are proportional and L_1 and C_2 inversely proportional to the band-width. Element values for a band-width of unity are the same as those given in Table I.

To find the values of capacity and inductance of a band-suppression filter with a characteristic impedance of 500 ohms proceed as follows:—L_2 of the shunt arm is equal to $\frac{1}{4}L_1$ of the band-pass filter, and L_1 of the series arm is equal to $4L_2$ of the band-pass filter. C_2 of the shunt arm, in series with L_2, is equal to $4C_1$ of the band-pass filter; and C_1 of the series arm in parallel with L_1 is equal to $\frac{1}{4}C_2$ of band-pass filter.

TABLE I LOW-PASS and HIGH-PASS FILTER DATA

	R = 500 ohms				R = 10,000 ohms			
	Low-pass		High-pass		Low-pass		High-pass	
f_c (cycles)	L_1 (henries)	C_2 (mfds.)	L_2 (henries)	C_1 (mfds.)	L_1 (henries)	C_2 (mfds.)	L_2 (henries)	C_1 (mfds.)
30	5.31	21.2	1.33	5.31	106.	1.06	26.5	.265
100	1.59	6.37	.398	1.59	31.8	.318	7.96	.0796
150	1.06	4.24	.265	1.06	21.2	.212	5.31	.0531
200	.796	3.18	.198	.796	15.9	.159	3.98	.0398
250	.637	2.55	.159	.637	12.7	.127	3.18	.0318
300	.531	2.12	.133	.531	10.6	.106	2.65	.0265
350	.455	1.82	.114	.455	9.09	.0909	2.28	.0228
400	.398	1.59	.0995	.398	7.96	.0796	1.99	.0199
450	.354	1.41	.0884	.354	7.07	.0707	1.77	.0177
500	.318	1.27	.0796	.318	6.37	.0637	1.59	.0159
550	.289	1.16	.0723	.289	5.78	.0578	1.45	.0145
600	.265	1.06	.0663	.265	5.31	.0531	1.33	.0133
650	.245	.979	.0612	.245	4.90	.0490	1.22	.0122
700	.227	.909	.0568	.227	4.54	.0454	1.14	.0114
750	.212	.849	.0531	.212	4.24	.0424	1.06	.0106
800	.199	.796	.0497	.199	3.98	.0398	.995	.00995
850	.187	.749	.0468	.187	3.74	.0374	.936	.00936
900	.177	.707	.0442	.177	3.54	.0354	.884	.00884
950	.168	.670	.0419	.168	3.36	.0336	.839	.00839
1*	.159	.637	.0398	.159	3.18	.0318	.796	.00796
3*	.0531	.212	.0133	.0531	1.06	.0106	.265	.00265
10*	.0159	.0637	.00398	.0159	.318	.00318	.0796	796#
30*	.00531	.0212	.00133	.00531	.106	.00106	.0265	265#
100*	.00159	.00637	398†	.00159	.0318	318#	.00796	79.6#
300*	581†	.00212	133†	531#	.0106	106#	.00265	26.5#
1**	159†	637#	39.8†	159#	.00318	31.8#	796†	7.96#
3**	53.1†	212#	13.3†	53.1#	.00106	10.6#	265†	2.65#
10**	15.9†	63.7#	3.98†	15.9#	318†	3.18#	79.6†	0.796#
30**	5.31†	21.2#	1.33†	5.31#	106†	1.06#	26.5†	0.265#

NOTE: *Kilocycles, **Megacycles, †Microhenries, #Micromicrofarads

TABLE II BAND-PASS FILTERS (R = 500 OHMS)

Band Width	f_m =	100 cycles	1000 cycles	1500 cycles	2000 cycles	2500 cycles	3000 cycles	3500 cycles	4000 cycles	4500 cycles	5000 cycles	5500 cycles	6000 cycles
	L_1	31.8	3.18	2.12	1.59	1.27	1.06	.909	.796	.707	.637	.579	.531
	L_2	.0199	.00199	.00133	995m	796m	663m	569m	497m	442m	398m	362m	332m
.05	C_1	.0796	.00796	.00531	.00398	.00318	.00265	.00227	.00199	.00177	.00159	.00145	.00133
	C_2	127	12.7	8.49	6.37	5.09	4.24	3.64	3.18	2.83	2.55	2.32	2.12
	L_1	15.9	1.59	1.06	.796	.637	.531	.455	.398	.354	.318	.289	.265
	L_2	.0398	.00398	.00265	.00199	.00159	.00133	.00114	995m	884m	796m	723m	663m
.1	C_1	.159	.0159	.0106	.00796	.00637	.00531	.00455	.00398	.00354	.00318	.00289	.00265
	C_2	63.7	6.37	4.24	3.18	2.55	2.12	1.82	1.59	1.41	1.27	1.16	1.06
	L_1	10.6	1.06	.707	.531	.424	.354	.303	.265	.236	.212	.193	.177
	L_2	.0597	.00597	.00398	.00298	.00239	.00199	.00171	.00149	.00133	.00119	.00109	995m
.15	C_1	.239	.0239	.0159	.0119	.00955	.00796	.00682	.00597	.00531	.00477	.00434	.00398
	C_2	42.4	4.24	2.83	2.12	1.70	1.41	1.21	1.06	.943	.849	.772	.707
	L_1	7.96	.796	.531	.398	.318	.265	.227	.199	.177	.159	.145	.133
	L_2	.0796	.00796	.00531	.00398	.00318	.00265	.00227	.00199	.00177	.00159	.00145	.00133
.2	C_1	.318	.0318	.0212	.0159	.0127	.0106	.00909	.00796	.00707	.00637	.00579	.00531
	C_2	31.8	3.18	2.12	1.59	1.27	1.06	.909	.796	.707	.637	.579	.531
	L_1	6.37	.637	.424	.318	.255	.212	.182	.159	.141	.127	.116	.106
	L_2	.0995	.00995	.00663	.00497	.00398	.00332	.00284	.00249	.00221	.00199	.00181	.00166
.25	C_1	.398	.0398	.0265	.0199	.0159	.0133	.0114	.00995	.00884	.00796	.00723	.00663
	C_2	25.5	2.55	1.70	1.27	1.01	.849	.728	.637	.566	.509	.463	.424
	L_1	5.31	.531	.354	.265	.212	.177	.152	.133	.118	.106	.0965	.0884
	L_2	.119	.0119	.00796	.00597	.00477	.00398	.00341	.00298	.00265	.00239	.00217	.00199
.3	C_1	.477	.0477	.0318	.0239	.0191	.0159	.0136	.0119	.0106	.00955	.00868	.00796
	C_2	21.2	2.12	1.41	1.06	.849	.707	.606	.531	.472	.424	.386	.354
	L_1	3.98	.398	.265	.199	.159	.133	.111	.0995	.0884	.0796	.0723	.0663
	L_2	.159	.0159	.0106	.00796	.00637	.00531	.00455	.00398	.00354	.00318	.00289	.00265
.4	C_1	.637	.0637	.0424	.0318	.0255	.0212	.0182	.0159	.0141	.0127	.0116	.0106
	C_2	15.9	1.59	1.06	.796	.637	.531	.455	.398	.354	.318	.289	.265
	L_1	3.18	.318	.212	.159	.127	.106	.0909	.0796	.0707	.0637	.0479	.0531
	L_2	.199	.0199	.0133	.00995	.00796	.00663	.00568	.00497	.00442	.00398	.00362	.00332
.5	C_1	.796	.0796	.0531	.0398	.0318	.0265	.0227	.0199	.0177	.0159	.0145	.0133
	C_2	12.7	1.27	.849	.637	.509	.424	.364	.318	.283	.255	.232	.212
	L_1	2.65	.265	.177	.133	.106	.0884	.0758	.0663	.0589	.0531	.0482	.0442
	L_2	.239	.0239	.0159	.0119	.00955	.00796	.00682	.00597	.00531	.00477	.00434	.00398
.6	C_1	.955	.0955	.0637	.0477	.0382	.0318	.0273	.0239	.0212	.0191	.0174	.0159
	C_2	10.6	1.06	.707	.531	.424	.354	.303	.265	.236	.212	.193	.177
	L_1	2.27	.227	.152	.114	.0909	.0758	.0650	.0568	.0505	.0455	.0413	.0379
	L_2	.279	.0279	.0186	.0139	.0111	.00928	.00796	.00696	.00619	.00557	.00506	.00464
.7	C_1	1.11	.111	.0742	.0557	.0446	.0371	.0318	.0279	.0248	.0223	.0203	.0186
	C_2	9.09	.909	.606	.455	.364	.303	.260	.227	.202	.182	.165	.152
	L_1	1.99	.199	.133	.0995	.0796	.0663	.0568	.0497	.0442	.0398	.0362	.0332
	L_2	.318	.0318	.0212	.0159	.0127	.0106	.00909	.00796	.00707	.00637	.00579	.00531
.8	C_1	1.27	.127	.0849	.0637	.0509	.0424	.0364	.0318	.0283	.0255	.0231	.0212
	C_2	7.96	.796	.531	.398	.318	.265	.227	.199	.177	.159	.145	.133
	L_1	1.77	.177	.118	.0884	.0707	.0589	.0505	.0442	.0393	.0354	.0322	.0294
	L_2	.358	.0358	.0239	.0179	.0143	.0119	.0102	.00895	.00796	.00716	.00651	.00597
.9	C_1	1.43	.143	.0955	.0716	.0573	.0477	.0409	.0358	.0318	.0286	.0260	.0239
	C_2	7.07	.707	.472	.354	.283	.236	.202	.177	.157	.141	.129	.118

m = microhenries

continued next page

AEROVOX BUILT BETTER CONDENSERS AND RESISTORS

TABLE II BAND-PASS FILTERS (R = 500 OHMS)

Band Width	f_m =	6500 cycles	7000 cycles	7500 cycles	8000 cycles	8500 cycles	9000 cycles	9500 cycles	10 kc.	100 kc.	1 mc.	10 mc.
	L_1	.490	.455	.424	.398	.374	.354	.335	.318	.0318	.00318	318m
	L_2	306m	284m	265m	249m	234m	221m	209m	199m	19.9m	1.99m	.199m
.05	C_1	.00122	.00114	.00106	995mmf.	936mmf.	884mmf.	838mmf.	796mmf.	79.6mmf.	7.96mmf.	.796mmf.
	C_2	1.96	1.82	1.70	1.59	1.50	1.41	1.34	1.27	.127	.0127	.00127
	L_1	.245	.227	.212	.199	.187	.177	.168	.159	.0159	.00159	159m
	L_2	612m	568m	531m	497m	468m	442m	419m	398m	39.8m	3.98m	.398m
.1	C_1	.00245	.00227	.00212	.00199	.00187	.00177	.00168	.00159	159mmf.	15.9mmf.	1.59mmf.
	C_2	.979	.909	.849	.796	.749	.707	.670	.637	.0637	.00637	637mmf.
	L_1	.163	.152	.141	.133	.125	.118	.112	.106	.0106	.00106	106m
	L_2	918m	852m	796m	746m	702m	663m	628m	597m	59.7m	5.97m	.597m
.15	C_1	.00367	.00341	.00318	.00298	.00281	.00265	.00251	.00239	239mmf.	23.9mmf.	2.39mmf.
	C_2	.653	.606	.566	.531	.499	.472	.447	.424	.0424	.00424	424mmf.
	L_1	.122	.114	.106	.0995	.0936	.0084	.0838	.0796	.00796	796m	79.6m
	L_2	.00122	.00114	.00106	.995m	936m	884m	838m	796m	79.6m	7.96m	.796m
.2	C_1	.00490	.00455	.00424	.00398	.00374	.00354	.00335	.00318	318mmf.	31.8mmf.	3.18mmf.
	C_2	.490	.455	.424	.398	.374	.354	.335	.318	.0318	.00318	318mmf.
	L_1	.0979	.0909	.0849	.0796	.0749	.0707	.0670	.0637	.00637	637m	63.7m
	L_2	.00153	.00142	.00133	.00124	.00117	.00111	.00105	995m	99.5m	9.95m	.995m
.25	C_1	.00612	.00568	.00531	.00497	.00468	.00442	.00419	.00398	398mmf.	39.8mmf.	3.98mmf.
	C_2	.392	.364	.340	.318	.300	.283	.268	.255	.0255	.00255	255mmf.
	L_1	.0816	.0758	.0707	.0663	.0624	.0589	.0558	.0531	.00531	531m	53.1m
	L_2	.00184	.00171	.00159	.00149	.00140	.00133	.00126	.00119	119m	11.9m	1.19m
.3	C_1	.00735	.00682	.00637	.00597	.00562	.00531	.00503	.00477	477mmf.	47.7mmf.	4.77mmf.
	C_2	.326	.303	.283	.265	.250	.236	.223	.212	.0212	.00212	212mmf.
	L_1	.0612	.0568	.0531	.0497	.0468	.0442	.0419	.0398	.00398	398m	39.8m
	L_2	.00245	.00227	.00212	.00199	.00187	.00177	.00168	.00159	159m	15.9m	1.59m
.4	C_1	.00979	.00909	.00849	.00796	.00749	.00707	.00670	.00637	637mmf.	63.7mmf.	6.37mmf.
	C_2	.245	.227	.212	.199	.187	.177	.168	.159	.0159	.00159	159mmf.
	L_1	.0490	.0455	.0424	.0398	.0374	.0354	.0335	.0318	.00318	318m	31.8m
	L_2	.00306	.00284	.00265	.00249	.00234	.00221	.00209	.00199	199m	19.9m	1.99m
.5	C_1	.0122	.0114	.0106	.00995	.00936	.00884	.00838	.00796	796mmf.	79.6mmf.	7.96mmf.
	C_2	.196	.182	.170	.159	.150	.141	.134	.127	.0127	.00127	127mmf.
	L_1	.0408	.0379	.0354	.0332	.0312	.0295	.0279	.0265	.00265	265m	26.5m
	L_2	.00367	.00341	.00318	.00298	.00281	.00265	.00251	.00239	239m	23.9m	2.39m
.6	C_1	.0147	.0136	.0127	.0119	.0113	.0106	.0101	.00955	955mmf.	95.5mmf.	9.55mmf.
	C_2	.163	.152	.141	.133	.125	.118	.112	.106	.0106	.00106	106mmf.
	L_1	.0350	.0325	.0303	.0284	.0267	.0253	.0239	.0227	.00227	227m	22.7m
	L_2	.00429	.00398	.00371	.00348	.00328	.00309	.00293	.00279	279m	27.9m	2.79m
.7	C_1	.0171	.0159	.0149	.0139	.0131	.0124	.0117	.0111	.00111	111mmf.	11.1mmf.
	C_2	.140	.130	.121	.114	.107	.101	.0957	.0909	.00909	909mmf.	9.09mmf.
	L_1	.0306	.0284	.0265	.0249	.0234	.0221	.0209	.0199	.00199	199m	19.9m
	L_2	.00490	.00455	.00424	.00398	.00374	.00254	.00335	.00318	318m	31.8m	3.18m
.8	C_1	.0196	.0182	.0170	.0159	.0150	.0141	.0134	.0127	.00127	127mmf.	12.7mmf.
	C_2	.122	.113	.106	.0995	.0936	.0884	.0838	.0796	.00796	796mmf.	79.6mmf.
	L_1	.0272	.0253	.0236	.0221	.0208	.0196	.0186	.0177	.00177	177m	17.7m
	L_2	.00551	.00512	.00477	.00448	.00421	.00398	.00377	.00358	[illegible].8m	35.8m	3.58m
.9	C_1	.0220	.0205	.0191	.0179	.0169	.1059	.0151	.0143	.00143	143mmf.	14.3mmf.
	C_2	.109	.101	.0943	.0884	.0832	.0786	.0745	.0707	.00707	707mmf.	70.7mmf.

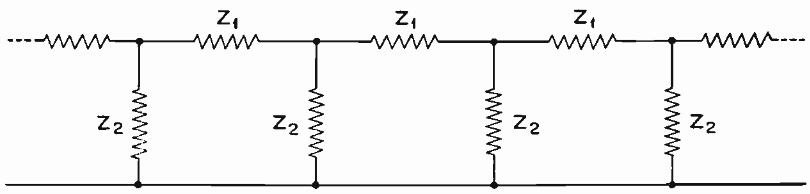


Figure 1

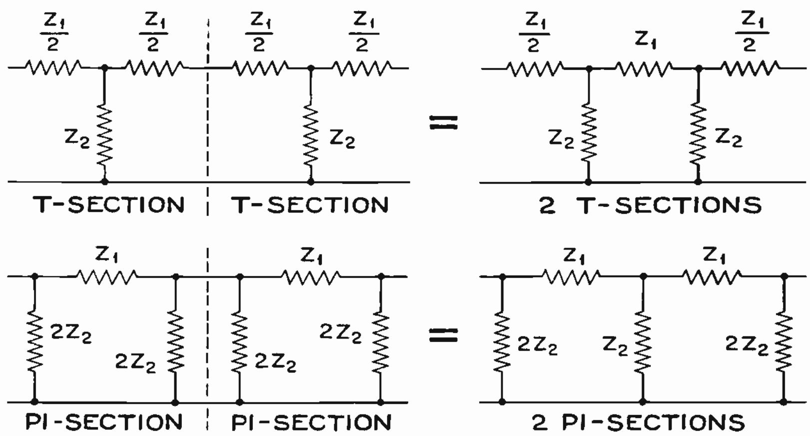
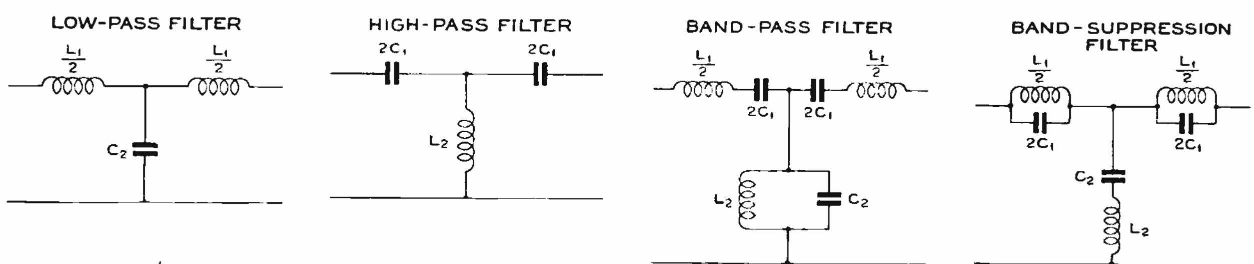


Figure 2



Low-pass filter

$$f_c = \frac{1}{\pi\sqrt{L_1 C_2}}$$

$$R = \sqrt{\frac{L_1}{C_2}}$$

$$L_1 = \frac{R}{\pi f_c} \qquad C_2 = \frac{1}{\pi f_c R}$$

High-pass filter

$$f_c = \frac{1}{4\pi\sqrt{L_2 C_1}}$$

$$R = \sqrt{\frac{L_2}{C_1}}$$

$$C_1 = \frac{1}{4\pi f_c R} \qquad L_2 = \frac{R}{4\pi f_c}$$

Band-pass filter

$$f_m = \sqrt{f_1 f_2}$$

$$f_m = \frac{1}{2\pi\sqrt{L_1 C_1}} = \frac{1}{2\pi\sqrt{L_2 C_2}}$$

$$R = \sqrt{\frac{L_1}{C_2}} = \sqrt{\frac{L_2}{C_1}}$$

$$L_1 = \frac{R}{\pi(f_2 - f_1)} \qquad C_1 = \frac{f_2 - f_1}{4\pi f_1 f_2 R}$$

$$L_2 = \frac{(f_2 - f_1)R}{4\pi f_1 f_2} \qquad C_2 = \frac{1}{\pi(f_2 - f_1)R}$$

Band-suppression filter

$$f_m = \sqrt{f_1 f_2}$$

$$f_m = \frac{1}{2\pi\sqrt{L_1 C_1}} = \frac{1}{2\pi\sqrt{L_2 C_2}}$$

$$R = \sqrt{\frac{L_1}{C_2}} = \sqrt{\frac{L_2}{C_1}}$$

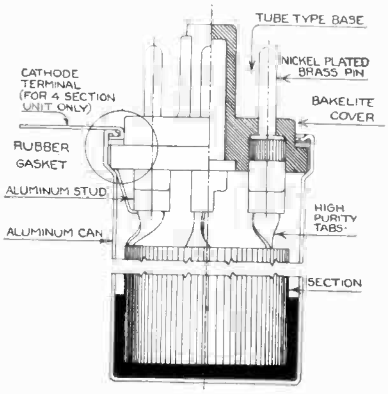
$$L_1 = \frac{(f_2 - f_1)R}{\pi f_1 f_2} \qquad C_1 = \frac{1}{4\pi(f_2 - f_1)R}$$

$$L_2 = \frac{R}{4\pi(f_2 - f_1)} \qquad C_2 = \frac{f_2 - f_1}{\pi f_1 f_2 R}$$

Figure 3

Something new and startling...

PLUG-IN ELECTROLYTICS



As shown above, octal base of Aerovox plug-in condenser is of special design and construction, made in Aerovox's own molding department.

Nickel-plated brass prongs engage with standard octal socket contacts of similar metal. Prongs connect with aluminum-section tabs through aluminum studs, as shown, with junctions imbedded in protective bakelite seal to eliminate corrosive effects. Aluminum studs spun over prong ends. Section tab placed in cylindrical recess of aluminum stud, and portion of stud wall is partly sheared and collapsed firmly on imbedded tab for permanently tight, low-resistance, aluminum-to-aluminum bond.

Hermetic sealing achieved by can edge spun over soft-rubber gasket and bakelite plug. Vented cover for full protection.

If standard octal socket is correctly wired, condenser simply cannot be incorrectly connected because of octal-base keying.

Units firmly gripped in octal sockets, just as in case of octal-base radio tubes and vibrators.

● Developed primarily for the U. S. Signal Corps and for use in aircraft and police radio, the new AEROVOX Series AP Plug-in Electrolytic Condensers are now available for other applications where, above all else, continuity of service is a prime requisite.

The far-reaching advantages of the plug-in electrolytic are at once obvious. Readily removed, tested, replaced, these octal-base condensers handle with the same ease as conventional radio tube or vibrator. Assemblies can be equipped with fresh plug-ins immediately prior to shipment or to actual use, which feature is vitally important in overseas radio trade. Users of radio or electronic equipment subject to continuous service, can carry "spares" on hand for instant replacement. Auto-radio and home-radio service is vastly simplified.

The many technical problems involved in producing a hermetically-sealed, leak-proof, corrosion-proof, octal-base plug-in condenser have been thoroughly solved. These units are available in the paper type as well as in electrolytic as herein listed.

AEROVOX TYPE AEP
Plug-In Electrolytics
Max. 525v. SURGE 450v. D.C. Work.

Cap. Mfds.	Size-Ins. Dia.-High	List Price
Type AEP-450—Single Section		
10	1-5/32 x 2-1/2	$1.25
20	1-5/32 x 2-1/2	1.75
40	1-5/32 x 2-1/2	3.05
80	1-5/32 x 4-1/4	4.25
Type AEP-450—Double Section		
10–10	1-5/32 x 2-1/2	1.95
20–20	1-5/32 x 3	2.75
Type AEP-450—Triple Section		
10-10-10	1-5/32 x 2-1/2	2.65
Type AEP 45025		
10-10 x 450 +20 x 25	1-5/32 x 2-1/2	2.65

Ask Your Jobber...

Ask to see this latest achievement in condensers. Use plug-in condensers in that next assembly intended for continuous, dependable service. Or write us direct.

AEROVOX CORPORATION

New Bedford, Mass.

Sales Offices in All Principal Cities