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Design Data for *m*-Derived Type Filters

PART IV

By the Engineering Department, Aerovox Corporation

CHART 2, accompanying this article, lists directly all L and C components required for series-derived band-pass filter sections for twenty-three mid-frequency values between 100 cycles and 10 megacycles and for twelve band-width values between 0.05 and 0.9.

These component values have been calculated for 500 ohms impedance. However, values for mid-frequencies and impedances other than those given in Chart 2 may be obtained by interpolation, all component values being inversely proportional to the mid-frequencies. The inductance values are directly proportional and the capacitance values inversely proportional to the characteristic impedance. It is convenient to find first the inductance and capacitance values corresponding to 500 ohms impedance. The L and C values then corresponding to a desired new impedance of Z ohms will be equal to the 500-ohm inductance multiplied by $z/500$, and the 500-ohm capacitance divided by $z/500$.

The band-width values are those commonly employed. Selection of values different from those given in the tables will entail recalculation of L and C values, since the band-edge frequencies, maximum attenuation, frequencies, and a, b, h, and m factors are all affected by alterations of band-width figures. No simple operation is available for converting L and C values when other band-width values are used.

In Chart 2, all inductance values are given in henries, except in the 10-Mc. column where listings are made in microhenries. All capacitance values are given in microfarads, except in the 10-kc., 100-kc., 1-Mc., and 10-Mc. columns where the listings are made in micromicrofarads.

Chart 2 may be used in conjunction with Chart 1 (Frequency Data, Band-Pass Filters) which appeared in Part III, January 1943, of this series, to determine the three L and three C values for series-derived band-pass filter sections. For example: employing both charts, it is found that a section with 1000-cycle mid-frequency and 0.05 band-width has upper and lower cut-off frequencies of 1025 and 975 cycles, respectively, and upper and lower infinite attenuation frequencies of 1076 and 926 cycles, respectively. The components required for this section are: L_1 3.02 hy., L_2 1.56 hy., L_3 2.42 hy., C_1 0.00837 mfd., C_2 0.0775 mfd., and C_3 0.0161 mfd.

A section with the same mid-frequency but with considerably wider pass band might have a band-width of 0.9 (See Chart 1, Part III). Here the upper and lower cut-off frequencies are 1550 cycles and 650 cycles, and the upper and lower infinite attenuation frequencies are 1627 cycles and 618 cycles. The components required (See Chart 2) are: L_1 0.081 hy., L_2 0.104 hy., L_3 0.275 hy., C_1 0.310 mfd., C_2 0.248 mfd., and C_3 0.240 mfd.

Pass-band width may thus be adjusted over a range of 18 to 1 for any mid-frequency by appropriate selection from values given in the first column of Chart 2. In order to obtain different attenuation characteristics, the maximum attenuation frequencies may be shifted toward or away from the cut-off frequencies. However, this change of values will necessitate recalculation of L_2, L_3, C_2 and C_3.

Components selected in accordance with inductance and capacitance values given by the Chart must be of the values specified. It is strongly recommended that the various components be resonated at the desired operating frequency in order to obtain closely-matched sections. The capacitors may thus be chosen first and resonated with inductors in suitable resonance testing setups or in standard resonance bridges.

A similar chart for shunt-derived components will appear in a later issue of the *Research Worker* and will be followed by design data for series- and shunt-derived band-suppression filters.

AEROVOX BUILT BETTER CONDENSERS AND RESISTORS

CHART 2—Series-Derived Band-Pass Filters (R = 500 Ohms)

Band Width		f_m = 100	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000
0.05	L_1	30.21	3.02	2.01	1.50	1.208	1.005	0.864	0.750	0.669	0.6042	0.5492	0.5025
	L_2	15.60	1.56	1.038	7.8	0.624	0.519	0.446	3.90	0.345	0.3120	0.2836	0.2595
	L_3	24.24	2.42	1.614	1.21	0.969	0.807	0.692	0.605	0.537	0.4848	0.4406	0.4035
	C_1	0.0837	0.00837	0.00556	0.00418	0.00334	0.00278	0.00238	0.0020	0.00184	0.00167	0.00152	0.00139
	C_2	0.775	0.0775	0.0516	0.0387	0.031	0.0258	0.022	0.0193	0.0171	0.0155	0.0141	0.0129
	C_3	0.161	0.0161	0.0107	0.00805	0.0064	0.00536	0.0046	0.0040	0.00356	0.0032	0.00290	0.00268
0.1	L_1	13.35	1.33	0.888	0.665	0.534	0.444	0.380	0.332	0.2956	0.2670	0.2427	0.222
	L_2	2.561	0.256	0.0170	0.128	0.1024	0.0852	0.072	0.064	0.0566	0.0512	0.0465	0.0426
	L_3	3.13	0.313	0.208	0.156	0.1252	0.104	0.0894	0.078	0.0692	0.0626	0.0569	0.0520
	C_1	0.0189	0.00189	0.00125	0.000945	0.000756	0.000629	0.00054	0.00047	0.00042	0.00038	0.000345	0.000314
	C_2	0.0802	0.00802	0.0053	0.00401	0.00320	0.00267	0.00228	0.0020	0.00176	0.0016	0.00145	0.00133
	C_3	0.983	0.0983	0.0654	0.0491	0.0393	0.0327	0.00280	0.0245	0.0216	0.0196	0.01781	0.01635
0.15	L_1	8.268	0.826	0.550	0.413	0.3307	0.275	0.236	0.2065	0.1830	0.0165	0.0149	0.1375
	L_2	2.42	0.242	0.159	0.121	0.0968	0.0795	0.068	0.0605	0.0528	0.0484	0.0439	0.03975
	L_3	3.08	0.308	0.2050	0.154	0.1232	0.1025	0.088	0.0770	0.0680	0.0616	0.0559	0.05125
	C_1	0.306	0.0306	0.0202	0.0153	0.0122	0.0101	0.00874	0.00765	0.0066	0.0061	0.0055	0.0050
	C_2	1.465	0.146	0.0974	0.073	0.0586	0.0487	0.0416	0.0365	0.0322	0.00117	0.0106	0.02435
	C_3	1.045	0.104	0.0694	0.052	0.0418	0.0347	0.0296	0.0260	0.233	0.00083	0.00075	0.01735
0.2	L_1	5.73	0.573	0.3816	0.286	0.229	0.1908	0.164	0.1430	0.1270	0.0045	0.0041	0.0954
	L_2	2.35	0.235	0.1564	0.117	0.094	0.0782	0.066	0.0585	0.0520	0.0018	0.0016	0.0391
	L_3	3.17	0.317	0.2110	0.158	0.1268	0.1055	0.0906	0.0790	0.0702	0.0025	0.0023	0.0527
	C_1	0.441	0.044	0.0292	0.022	0.0176	0.0146	0.0124	0.0110	0.0098	0.00035	0.00031	0.0073
	C_2	0.813	0.081	0.0540	0.0405	0.0325	0.0270	0.0230	0.0202	0.0178	0.00065	0.00059	0.0135
	C_3	1.094	0.109	0.0728	0.054	0.0437	0.0364	0.0310	0.027	0.0242	0.0022	0.0019	0.0182
0.25	L_1	4.52	0.452	0.3010	0.226	0.1808	0.1505	0.128	0.1130	0.100	0.00361	0.00328	0.0752
	L_2	1.91	0.191	0.1272	0.095	0.0764	0.0636	0.0546	0.0475	0.0422	0.00152	0.00138	0.0318
	L_3	2.56	0.256	0.1704	0.128	0.1024	0.0852	0.0732	0.064	0.0566	0.00204	0.00185	0.0426
	C_1	0.560	0.056	0.0372	0.028	0.0224	0.0186	0.0160	0.0140	0.0124	0.00044	0.000399	0.0093
	C_2	0.935	0.093	0.0622	0.046	0.0374	0.0311	0.0264	0.0230	0.0206	0.00074	0.00067	0.0155
	C_3	1.323	0.132	0.0880	0.066	0.0529	0.0440	0.0376	0.0330	0.0029	0.0010	0.00091	0.022
0.3	L_1	3.61	0.361	0.240	0.180	0.1444	0.120	0.1032	0.090	0.0798	0.0028	0.00254	0.060
	L_2	1.77	0.177	0.1178	0.088	0.0708	0.0589	0.0506	0.044	0.0390	0.0014	0.0013	0.0294
	L_3	2.64	0.264	0.1758	0.132	0.1056	0.0879	0.0754	0.066	0.0584	0.0021	0.00190	0.0439
	C_1	0.701	0.0701	0.0466	0.035	0.0280	0.0233	0.2000	0.0175	0.0154	0.00056	0.00051	0.0116
	C_2	0.958	0.0958	0.0638	0.0479	0.0383	0.0319	0.2738	0.2395	0.0210	0.00076	0.00069	0.0159
	C_3	1.424	0.142	0.0948	0.071	0.0569	0.0474	0.0406	0.0355	0.0314	0.00113	0.00102	0.0237
0.4	L_1	2.86	0.286	0.1904	0.143	0.1144	0.0952	0.0816	0.0715	0.0634	0.0022	0.00199	0.0476
	L_2	1.08	0.108	0.0718	0.054	0.0432	0.0359	0.0308	0.0270	0.0238	0.00086	0.00078	0.0179
	L_3	1.78	0.178	0.1184	0.089	0.0712	0.0592	0.0508	0.0445	0.0394	0.0014	0.00127	0.0296
	C_1	0.884	0.088	0.0588	0.044	0.0353	0.0294	0.0250	0.022	0.0196	0.00070	0.00063	0.0147
	C_2	1.448	0.144	0.0964	0.072	0.0579	0.0482	0.0410	0.036	0.032	0.00115	0.00104	0.0241
	C_3	2.375	0.237	0.1580	0.1185	0.0950	0.0790	0.0676	0.0592	0.0526	0.0019	0.00172	0.0395
0.5	L_1	1.71	0.171	0.1138	0.085	0.0684	0.0569	0.0488	0.0425	0.0182	0.00137	0.00124	0.0284
	L_2	1.64	0.164	0.1092	0.082	0.0656	0.0546	0.0468	0.0410	0.0362	0.00131	0.00119	0.0273
	L_3	2.93	0.293	0.1950	0.146	0.1172	0.0975	0.0836	0.0730	0.0648	0.00234	0.00212	0.0487
	C_1	1.472	0.147	0.0980	0.0735	0.0588	0.0490	0.0420	0.0367	0.0326	0.00117	0.00106	0.0245
	C_2	0.854	0.085	0.0568	0.0425	0.0341	0.0284	0.0242	0.0212	0.0188	0.00068	0.00062	0.0142
	C_3	1.526	0.152	0.0350	0.076	0.0210	0.0175	0.0434	0.0380	0.1164	0.00042	0.00038	0.00875
0.6	L_1	1.37	0.137	0.0912	0.068	0.0548	0.0456	0.0390	0.0340	0.0302	0.0020	0.00181	0.0228
	L_2	1.39	0.139	0.924	0.069	0.0556	0.462	0.0396	0.0345	0.0306	0.00111	0.00100	0.0231
	L_3	2.77	0.277	0.1844	0.138	0.1108	0.0922	0.0792	0.0690	0.0614	0.0022	0.00199	0.0461
	C_1	1.836	0.183	0.1222	0.0915	0.0734	0.0611	0.0522	0.0457	0.0406	0.00146	0.00132	0.0305
	C_2	0.900	0.090	0.0598	0.045	0.0360	0.0299	0.0256	0.0225	0.0198	0.00072	0.00065	0.0149
	C_3	1.808	0.180	0.1204	0.090	0.0723	0.0602	0.0514	0.0450	0.040	0.0014	0.00127	0.0301
0.7	L_1	1.15	0.115	0.0764	0.057	0.0460	0.0382	0.0328	0.0285	0.0254	0.00092	0.00083	0.0191
	L_2	1.23	0.123	0.0818	0.061	0.0492	0.0409	0.0350	0.0305	0.0270	0.00098	0.00089	0.0204
	L_3	2.61	0.261	0.1738	0.130	0.1044	0.0869	0.0706	0.0650	0.0578	0.0020	0.00181	0.0434
	C_1	2.176	0.217	0.1448	0.1085	0.0870	0.0724	0.0620	0.0542	0.0482	0.0017	0.00154	0.0362
	C_2	0.956	0.095	0.0636	0.0475	0.0382	0.0318	0.0270	0.0237	0.0210	0.00076	0.00069	0.0159
	C_3	2.094	0.209	0.1394	0.0104	0.0837	0.0697	0.0596	0.0052	0.0462	0.00167	0.00151	0.0348
0.8	L_1	0.895	0.089	0.0596	0.044	0.0358	0.0298	0.0254	0.0220	0.0198	0.00071	0.00064	0.0149
	L_2	1.25	0.125	0.0832	0.062	0.0500	0.0416	0.0356	0.0310	0.0276	0.0010	0.00091	0.0208
	L_3	3.00	0.300	0.1998	0.150	0.1200	0.0999	0.0858	0.0750	0.0664	0.0024	0.00218	0.0499
	C_1	2.822	0.282	0.1878	0.141	0.1128	0.0939	0.0806	0.0705	0.0624	0.0022	0.00199	0.0469
	C_2	0.840	0.084	0.0558	0.042	0.0336	0.0279	0.0240	0.0210	0.0184	0.00067	0.00061	0.0139
	C_3	2.016	0.201	0.1342	0.1005	0.0806	0.0671	0.0574	0.0502	0.0446	0.0016	0.00145	0.0335
0.9	L_1	0.814	0.081	0.0542	0.040	0.0325	0.0271	0.0230	0.0200	0.0178	0.00065	0.00059	0.0135
	L_2	1.04	0.104	0.0692	0.052	0.0416	0.0346	0.0296	0.0260	0.0230	0.00083	0.00075	0.0173
	L_3	2.75	0.275	0.1830	0.137	0.1100	0.0915	0.0786	0.0685	0.0608	0.0022	0.00199	0.0457
	C_1	3.108	0.310	0.2068	0.1550	0.1243	0.1034	0.0886	0.0775	0.0688	0.0024	0.00218	0.0517
	C_2	2.480	0.248	0.1650	0.1240	0.0992	0.0825	0.0708	0.0620	0.0548	0.00198	0.00179	0.0412
	C_3	2.400	0.240	0.1598	0.1200	0.0960	0.0799	0.0686	0.0600	0.0530	0.00192	0.00174	0.0399

C: Mfds. **L:** Henries.

AEROVOX BUILT BETTER CONDENSERS AND RESISTORS

CHART 2—Series-Derived Band-Pass Filters (R = 500 Ohms)

Band Width		f_m = 6500	7000	7500	8000	8500	9000	9500	10 kc.*	100 kc.*	1 Mc.*	10 Mc.*
0.05	L_1	0.4673	0.432	0.402	0.375	0.352	0.334	0.317	0.302	0.0302	0.00302	302.1 mh
	L_2	0.2413	0.223	0.207	1.95	1.83	0.1718	0.1632	0.156	0.0156	0.00156	156
	L_3	0.3833	0.346	0.323	0.3025	0.2843	0.2687	0.255	0.242	0.0242	0.00242	242.4
	C_1	0.00129	0.00119	0.00111	0.0010	0.00094	0.00092	0.00087	837 mmfd.	83.7 mmfd.	8.37 mmfd.	0.837 mmfd.
	C_2	0.01199	0.011	0.0103	0.00965	0.00907	0.00859	0.00816	7752	775.2	77.52	7.752
	C_3	0.00250	0.0023	0.00214	0.0020	0.00188	0.00178	0.00169	0.01615	1615	161.5	16.15
0.1	L_1	0.206	0.190	0.177	0.166	0.156	0.1478	0.1384	0.133	0.0133	0.00133	133.56
	L_2	0.0396	0.036	0.034	0.032	0.030	0.0283	0.0268	0.0256	0.00256	0.000256	25.61
	L_3	0.0483	0.0447	0.0416	0.039	0.036	0.0346	0.0328	0.0313	0.00313	0.000313	31.38
	C_1	0.00020	0.000270	0.000251	0.000235	0.00022	0.00021	0.000199	1890	189	18.9	1.89
	C_2	0.00123	0.00114	0.00106	0.0010	0.00094	0.00088	0.000836	802	80.2	80.2	8.02
	C_3	0.0152	0.0140	0.0131	0.0122	0.0114	0.0108	0.0102	9830	983	98.3	9.83
0.15	L_1	0.1278	0.118	0.1101	0.1032	0.097	0.0915	0.0869	0.0826	0.00826	0.000826	82.68
	L_2	0.0369	0.034	0.0323	0.0302	0.0283	0.0264	0.0250	0.0242	0.00242	0.0002419	24.19
	L_3	0.0476	0.044	0.0409	0.0385	0.0361	0.0340	0.0323	0.0308	0.00308	0.000308	30.82
	C_1	0.00465	0.00437	0.00406	0.00382	0.00359	0.0033	0.0031	3060	306	30.6	3.06
	C_2	0.0226	0.0208	0.0295	0.0182	0.0171	0.0161	0.0151	0.0146	1465	146.5	14.65
	C_3	0.0161	0.0148	0.0135	0.0130	0.0122	0.0115	0.0109	0.0104	1045	104.5	10.45
0.2	L_1	0.0887	0.082	0.0762	0.0715	0.0672	0.0635	0.0603	0.0573	0.00573	0.000573	57.3
	L_2	0.0363	0.033	0.0313	0.0292	0.0274	0.0260	0.0247	0.0235	0.00235	0.000235	23.58
	L_3	0.049	0.0453	0.0430	0.0395	0.0371	0.0351	0.333	0.0317	0.00317	0.000317	31.72
	C_1	0.00678	0.0062	0.00586	0.0055	0.0051	0.0049	0.0046	4410	441	44.1	4.41
	C_2	0.0125	0.0115	0.0108	0.0101	0.0094	0.0089	0.00845	8130	813	81.3	8.13
	C_3	0.0169	0.0155	0.0145	0.0135	0.0126	0.0121	0.0114	0.0109	1094	109.4	10.94
0.25	L_1	0.0699	0.064	0.0602	0.0565	0.0531	0.0500	0.0475	0.0452	0.00452	0.000452	45.22
	L_2	0.0296	0.0273	0.0254	0.0237	0.0222	0.0211	0.0200	0.0191	0.00191	0.000191	19.13
	L_3	0.0396	0.0366	0.0341	0.0320	0.0300	0.0283	0.0268	0.0256	0.00256	0.000256	25.63
	C_1	0.0086	0.0080	0.00745	0.0070	0.0065	0.0062	0.0058	5600	560	56.0	5.60
	C_2	0.0144	0.0132	0.0124	0.0115	0.0108	0.0103	0.0097	9350	935	93.5	9.35
	C_3	0.0204	0.0188	0.0176	0.0165	0.0155	0.00146	0.00138	0.0132	1323	132.3	13.23
0.3	L_1	0.0558	0.0516	0.0481	0.0450	0.0423	0.0399	0.0379	0.0361	0.00361	0.000361	36.10
	L_2	0.0273	0.0253	0.0236	0.0220	0.0206	0.0195	0.0185	0.0177	0.00177	0.000177	17.77
	L_3	0.0408	0.0377	0.0351	0.0330	0.0310	0.0292	0.0277	0.0264	0.00264	0.000264	26.42
	C_1	0.0107	0.1000	0.00934	0.00875	0.00822	0.0077	0.0073	7010	701	70.1	7.01
	C_2	0.0147	0.1369	0.0127	0.1197	0.1125	0.0105	0.0099	9580	958	95.80	9.58
	C_3	0.0220	0.0203	0.0189	0.0177	0.0166	0.0157	0.0149	0.0142	1424	142.4	14.24
0.4	L_1	0.0442	0.0408	0.0381	0.0357	0.0335	0.0317	0.0301	0.0286	0.00286	0.000286	28.65
	L_2	0.0166	0.0154	0.0144	0.0135	0.0126	0.0119	0.0113	0.0108	0.00108	0.000108	10.87
	L_3	0.0275	0.0254	0.0237	0.0222	0.0208	0.0197	0.0186	0.0178	0.00178	0.000178	17.83
	C_1	0.0136	0.0125	0.0123	0.0110	0.0103	0.00979	0.0093	8840	884	88.4	8.84
	C_2	0.0224	0.0205	0.0193	0.0180	0.0169	0.016	0.0152	0.0144	1448	144.8	14.48
	C_3	0.0367	0.0338	0.0316	0.0296	0.0278	0.0263	0.0249	0.0237	2375	237.5	23.75
0.5	L_1	0.0264	0.0244	0.0227	0.0212	0.0199	0.0091	0.0086	0.0171	0.00171	0.000171	17.1
	L_2	0.0253	0.0234	0.0218	0.0205	0.0192	0.0181	0.0171	0.0164	0.00164	0.000164	16.4
	L_3	0.0453	0.0418	0.0390	0.0365	0.0343	0.0324	0.0307	0.0293	0.00293	0.000293	29.31
	C_1	0.0227	0.0210	0.0196	0.0183	0.0172	0.0163	0.0154	0.0147	1472	147.2	14.72
	C_2	0.0132	0.0121	0.0114	0.0106	0.0099	0.0094	0.0089	8540	854	85.4	8.54
	C_3	0.00813	0.0217	0.0070	0.0190	0.0178	0.0582	0.055	0.0152	1526	152.6	15.26
0.6	L_1	0.0212	0.0195	0.0182	0.0170	0.0159	0.0151	0.0103	0.0137	0.00137	0.000137	13.78
	L_2	0.0215	0.0198	0.0185	0.0172	0.0161	0.0153	0.0145	0.0139	0.00139	0.000139	13.91
	L_3	0.0428	0.0396	0.0370	0.0345	0.0324	0.0307	0.0291	0.0277	0.00277	0.000277	27.71
	C_1	0.0283	0.0261	0.0244	0.0228	0.0214	0.0203	0.0192	0.0183	1836	183.6	18.36
	C_2	0.0138	0.0128	0.0119	0.0112	0.0105	0.0099	0.0094	9000	900	90.0	9.00
	C_3	0.0279	0.0257	0.0241	0.0225	0.0211	0.020	0.0190	0.0180	1808	180.8	18.08
0.7	L_1	0.0177	0.0164	0.0153	0.0142	0.0133	0.0127	0.0120	0.0115	0.00115	0.000115	11.57
	L_2	0.0189	0.0175	0.00639	0.0152	0.0142	0.0135	0.0128	0.0123	0.00123	0.000123	12.33
	L_3	0.0403	0.0353	0.0347	0.0325	0.0305	0.0289	0.0274	0.0261	0.00261	0.000261	26.12
	C_1	0.0336	0.0310	0.0289	0.0271	0.0254	0.0241	0.0228	0.0217	2176	217.6	21.76
	C_2	0.0147	0.0135	0.0127	0.0118	0.0110	0.0105	0.00997	9560	956	95.6	9.56
	C_3	0.0323	0.0298	0.0279	0.00260	0.00244	0.0231	0.0219	0.0209	2094	209.4	20.94
0.8	L_1	0.0138	0.0127	0.0119	0.0110	0.0103	0.0099	0.0094	0.00895	0.000895	0.0000895	8.95
	L_2	0.0193	0.0178	0.0166	0.0155	0.0145	0.0138	0.0131	0.0125	0.00125	0.000125	12.53
	L_3	0.0464	0.0429	0.040	0.0375	0.0352	0.0332	0.0315	0.030	0.0030	0.00030	30.09
	C_1	0.0437	0.0403	0.0375	0.0352	0.0330	0.0312	0.0296	0.0282	2822	282.2	28.22
	C_2	0.0129	0.0120	0.0112	0.0105	0.0098	0.00920	0.00874	8400	840	84.0	8.40
	C_3	0.0311	0.0287	0.0268	0.0251	0.0235	0.0223	0.0211	0.0201	2016	201.6	20.16
0.9	L_1	0.0125	0.0115	0.0108	0.0100	0.0094	0.0089	0.00845	0.00814	0.000814	0.0000814	8.142
	L_2	0.0161	0.0148	0.0138	0.0130	0.0122	0.0115	0.0109	0.0104	0.00104	0.000104	10.48
	L_3	0.0425	0.0393	0.0366	0.0342	0.0321	0.0304	0.0288	0.0275	0.00275	0.000275	27.57
	C_1	0.0481	0.0443	0.0414	0.0387	0.0363	0.0344	0.0326	0.0310	3108	310.8	31.08
	C_2	0.0383	0.0354	0.0330	0.0310	0.0291	0.0274	0.0260	0.0248	2480	248.0	24.80
	C_3	0.0371	0.0343	0.0319	0.0300	0.0282	0.0265	0.0251	0.0240	2400	240.0	24.00

* **C:** Mmfds. in last four columns. **L:** Microhenries in 10-Mc. column. Mfds. and Henries in all other columns.

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