SHEET #8

Tele-Hints

(NOTES FROM AN ENGINEER'S NOTEBOOK)

Subject:

air dux

INDUCTANCE EQUIVALENTS

	AIR DUX	B&W	DIA	TPI
	404T	3001		4
	406T	----		6
2'	408T	3002	1/2"	8
	410T	----		10
	416T	3003		16
	432T	3004		32
	504T	3005		4
	506T	----		6
2"	508T	3006	5/8"	8
	510T	----		10
	516T	3007		16
	532T	3008		32
	604T	3009		4
	606T	----		6
2'	608T	3010	3/4"	8
	610T	----		10
	616T	3011		16
	632T	3012		32
	804T	3013		4
	806T	----		6
3"	808T	3014	1"	8
	810T	----		10
	816T	3015		16
	832T	3016		32
	1004T	3017		4
	1006T	----		6
	1008T	3018	1¼"	8
	1010T	----		10
	1016T	3019		16
	1032T	3020		32
	1204T	3021		4
	1206T	----		6
	1208T	3022	1½"	8
	1210T	----		10
	1216T	3023		16
	1232T	3024		32
	1404T	----		4
	1406T	----		6
	1408T	----	1¾"	8
	1410T	----		10
	1416T	----		16
	1432T	----		32
	1604T	----		4
	1606T	----		6
	1608T	3900	2"	8
	1610T	3907-1		10
	1616T	----		16
	2004T	----		4
	2006T	3905-1		6
	2008T	3906-1	2½"	8
	2010T			10
	2404T	----		4
	2406T	----		6
	2408T	----	3"	8
	2410T	----		10

Air Dux are 10" long
B&W -4" long

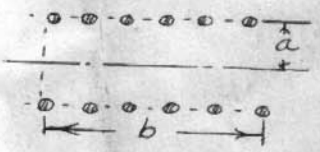
Above are tinned copper wire-also available in formvar or silver plated wire.

Are wound on low loss polystyrene rods.

CALCULATION OF INDUCTANCE

(See Sheet #7 for inductance chart of all AIR DUX Coils)

or use formula



$$L = \frac{a^2 N^2}{9a + 10b}$$

Where N= Total Turns
a= radius in inches
b= winding length in inches.

Turns may be space wound or close wound

The INDUCTANCE of coils with air cores is.
(a) Proportional to the square of the number of turns if the length and diameter of winding are kept constant as the number of turns are altered.
(b) Proportional to the size (length or shape) of coils having same shape (b/a) and same number of turns.
Thus-2 coils, one twice as big as the other with same no. of turns has twice the inductance of the smaller.

THE Q of a COIL

$$Q = \frac{2\pi f L}{R}$$

The Q of a coil is dependent on a number of relative factors such as physical size, wire diameter, form factor etc.

To obtain highest Q:
(a) Choose a size of coil where the length is moderately greater than the diameter.
(b) Then choose wire size so that wire diameter occupies .5 to .75 of spacing between turns.
(c) The LARGER the physical size of the coil, the HIGHER the Q will be-the fewer the number of turns required to obtain a given inductance-the larger will be the optimum wire diameter.

MUTUAL INDUCTANCE

The coefficient of coupling (K) between two coils:

$$K = \frac{M}{\sqrt{L_1 L_2}}$$

where M is mutual inductance
L_1 is inductance of 1st coil
L_2 is inductance of 2nd coil.

M, L_1 and L_2 can be in any units as long as they are all the same in henries, microhenries, etc.

Under conditions of resonance the load, antenna, dummy etc. couples resistance into the tank circuit in the amount:

$$\frac{(2\pi f M)^2}{R}$$

where f is the frequency in cycles per second and R is the resistance of the LOAD.

Hence the LOADED Q of your tank circuit can be determined by knowing M if you know K.

(1) K varies from 0.35 to 0.37 if the coupling link is in the center of the tank but of the same diameter.
(2) When the link is over one end, the K is approximately 0.3.
(3) When the link is of the same diameter as coil but spaced slightly off the end, the K is approximately 0.2.
(4) There is little reduction of K if the link in the center is wound over the tank coil on a larger diameter form.
(5) When the link is of smaller diameter, K decreases in proportion to the reduction in diameter.

TANK COIL OVER HEATING!

If the tank coil is heating it may not need larger wire-excessive circulating current in the tank may be the cause. If this is the case-your final is POORLY designed and only a SMALL PORTION of your power is ending up at the antenna. Now, we could suggest using a very large conductor size and the AIR DUX would not heat up as much BUT.. this would not SOLVE the problem. This large circulating current is passing through your switches and condenser which is not good and eventual failure is probable. Here are some points to keep in mind:

(1) Tank (pi network) circuit inductance is inversely proportional to EFFECTIVE Q of circuit, other things (load V, power output and frequency) being equal

$$Q_{EFFECTIVE} = \frac{\omega L}{R_{COIL} + R_{coupled\ from\ load}}$$

The EFFECTIVE Q is the ratio of coil reactance to the SUM of the resistance inherent in coil and resistance coupled into the tank circuit by the load.

(2) A high effective Q corresponds to a low L/C ratio with a resultant large circulating current, which, flowing through the resistance inherent in the coil causes heating. Conversely a lower effective Q corresponds to a high L/C ratio and a lower circulating current.

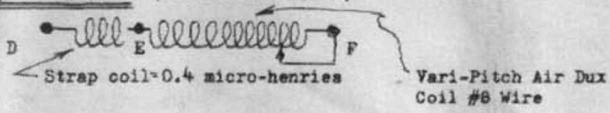
WIRE SIZE AND CAPACITOR SPACING VERSUS WATTS

(Condenser spacing based on representative voltages of input condenser of a pi network or tank condenser in a parallel tuned tank)

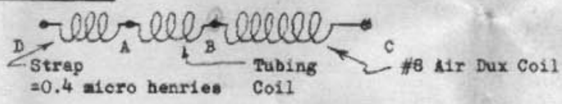
BAND	POWER INPUT	WIRE SIZE	CONDENSER SPACING
3.5	1000W	10	0.25"
7.0		8	0.25
14.0		8 or ¼" tube	0.25
28.Mc		6 or ⅜" tube	0.25
3.5	500W	14	0.08
7.0		12	0.08
14.0		12	0.08
28.		8 or ¼" tube	0.05
3.5	150W	18	.03"
7.0		14	.03"
14.0		14	.03"
28.0		12	.03"
3.5	75W	18	.02"
7.0		18	.02"
14.0		18	.02"
28.0		14	.02"

The output capacitor of pi network need not be more than .015" for a 50 ohms load at 1000W input. For lower powers receiving condensers may be used in most cases.

PI-DUX #195-1 (conservative 500W)



PI-DUX #195-2 (1 KW)



MOUNTING: The coil may be mounted on standoff insulators in either a horizontal or vertical position and should be well spaced from the chassis or shielding.
CONNECTING LEADS: It is best that the connecting leads be ½" wide copper strap and that the terminals be well soldered onto the coil.
TAP POSITIONS: The colored markings on the coils are for an estimated tube load of 1000 ohms working through the PI network into a 50 ohm line.
If your design conditions are different from this, reference should be made to the charts.

CHART #1 INDUCTANCE* in micro-henries. (measured from point D)

195-1	195-2	Turns	195-1	195-2
E	A	0	0.4	0.4
		1	0.8	0.45
		2	1.3	0.6
		3	1.6	0.8
	B	4	2.0	1.2
		5	2.7	1.6
		6	3.4	2.2
		7	4.0	2.7
		8	4.7	3.4
		9	5.6	4.2
		10	6.4	5.2
		11	7.2	6.1
		12	7.9	6.9
		13	8.8	8.0
		14	9.3	9.1
		15	10.7	10.3
		16	11.7	11.2
		17	12.7	12.6
		18	13.9	14.0
		19	15.2	15.2
F	C	20	16.4	16.4

L measured in terminals (no lead inductance)

*Measurements using #260 A Boonton Q Meter.

Estimated Plate Load= $\frac{E_b}{2I_b}$ (E_b=Plate Supply Volts)
(I_b=DC Plate Amps)

EXAMPLE: A pair of RCA 813's in parallel, C. W. operation into 50 ohms coax at 7.Mc. E_b=2250V, I_b=440 Ma. Power out=750W
Estimated plate load= 2250/2 (.440)=2560 ohms. Referring to table in the 2500 ohm column the values at 7Mc are L=5.2 micro-henries, C_1=105 mmfd, C_2=760 mmfd. From chart for #195-2 the shorting connection should be placed on turn number 10. Therefore the total L in circuit is composed of the 4 turn strap, the 4 turn tubing coil and 6 turns of the #8 wire coil.

Typical lead inductance using ½" wide strap in PI Networks vary from 0.1 to 0.4 micro-henries. No allowance has been made in example for lead inductance.

TYPICAL TUNING CAPACITOR PLATE SPACING

Plate Volts	1000	1200	1500	2000	3000	3500
Spacing	0.015"	.02"	.03"	.05"	.07"	.08"

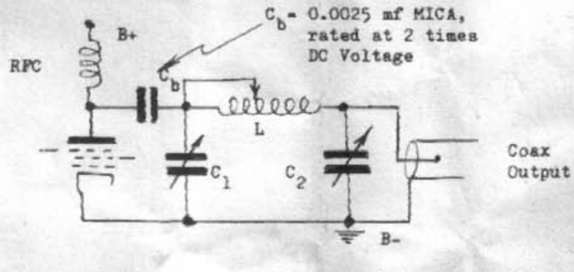
*The above table was obtained from RCA HAM.TIPS art:by M.Seyhold

SPECIAL APPLICATIONS for manufacturers

Illumitronic Engineering is equipped to design and produce coils for volume requirements.
AIR DUX may be made to varied specifications to meet every need.

WIRE may be supplied in bare, tinned, silver plated, and formvar copper.
MOUNTING—any number of mounting methods and materials can be utilized.
INDENTING of alternate turns in adjacent sections may be employed for tapping.
ENGINEERING—if you have an engineering problem, our staff would be happy to design an AIR DUX coil to meet your needs.

QUOTATIONS—upon request.



RFC....#28 Formvar wire, close wound on ceramic insulator 1" diameter 4" long.

C_1 and C_2 and L-see table A

Table A Components for Pi-Coupled Final Amplifiers* For Q=12

Estimated Plate Load (ohms)		1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	6,000*	NOTES
C_1 in μμf,	3.5 Mc	520	360	280	210	180	155	135	120	110	90	The actual capacitance setting for C_1 equals the value in this table minus the published tube output capacitance. Air gap approx. 10 mils/100 v E_b.
	7	260	180	140	105	90	76	68	60	56	45	
	14	130	90	70	52	45	38	34	30	28	23	
	21	85	60	47	35	31	25	23	20	19	15	
	28	65	45	35	26	23	19	17	15	14	11	
L in μh,	3.5 Mc	4.5	6.5	8.5	10.5	12.5	14	15.5	18	20	25	Inductance values are for a 50-ohm load. For a 70-ohm load, values are approx. 3% higher.
	7	2.2	3.2	4.2	5.2	6.2	7	7.8	9	10	12.5	
	14	1.1	1.6	2.1	2.6	3.1	3.5	3.9	4.5	5	6.2	
	21	0.73	1.08	1.38	1.7	2.05	2.3	2.6	3	3.3	4.1	
	28	0.55	0.8	1.05	1.28	1.55	1.7	1.95	2.25	2.5	3.1	
C_2 in μμf,	3.5 Mc	2,400	2,100	1,800	1,550	1,400	1,250	1,100	1,000	900	700	For 50-ohm transmission line. Air gap for C_2 is approx. 1 mil/100 v E_b.
	7	1,200	1,060	900	760	700	630	560	500	460	350	
	14	600	530	450	380	350	320	280	250	230	175	
	21	400	350	300	250	230	210	185	165	155	120	
	28	300	265	225	190	175	160	140	125	115	90	
C_2 in μμf,	3.5 Mc	1,800	1,500	1,300	1,100	1,000	900	800	720	640	500	For 70-ohm transmission line.
	7	900	750	650	560	500	450	400	360	320	250	
	14	450	370	320	280	250	220	200	180	160	125	
	21	300	250	215	190	170	145	130	120	110	85	
	28	225	185	160	140	125	110	100	90	80	65	

For other Q Values

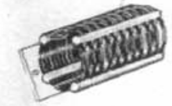
$$\frac{Q_a}{Q_b} = \frac{C_a}{C_b} = \frac{L_b}{L_a}$$

PI AIR DUX® COILS

New series for pi output circuits; may be used in LC output, interstage and oscillator circuits. Units adapt to a wide range of tube and load impedances, high or low power transmitters. Made with bright tinned copper wire, polystyrene coil supports, and plastic mounting strip. **Indented Coils** for easy connecting of taps by clip or soldering. **Variable Pitch Coils** for easy inductance matching at high frequencies.

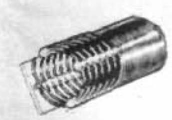
indented pi dux®

Cat. No.	Dia	TPI	Wire Size	Length of Coil	L uh.
816A	1	16	18	3 3/16	18.0
1014A	1¼	14	18	2 25/32	18.3
1212A	1½	12	16	2¾	18.3
1411A	1¾	11	14	2⅜	18.0
1609A	2	9	14	3	18.1
2007A	2½	7	12	3¼	18.6
2406A	3	6	10	3 3/16	18.7

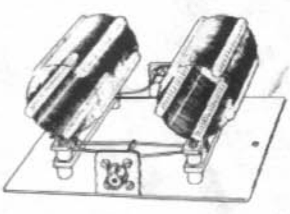


vari-pitch pi dux®

Cat. No.	Dia	TPI	Wire Size	Length of Coil	L uh.
820D10	1	20 & 10	18	3¼	18.0
1212D6	1½	12 & 6	14	3 13/16	18.6
1608D6	2	8 & 6	12	4⅛	18.1
2008D5	2½	8 & 5	12	3¾	18.2
2408D4	3	8 & 4	10	3¾	18.6



AIR DUX® BALUNS



Balun coils that match impedance in both transmitters and receivers, without adjustment, from 10 through 80 meters. For matching 75 ohms unbalanced to 300 ohms or 75 ohms balanced. Will easily handle outputs from transmitters with power up to 200 watts. For mounting, coil centers should be 4½" to 5" apart.

Illumitronic No. B2009—One balun coil (two required) with plastic mounting strips, insulators and hardware.

Illumitronic No. MB2009—Metal mounting plate with plastic terminal plate and hardware (less coax connector).