SPEC-D-SNAP SETS W38440
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W42603

DATE 12-13 1963
EQUIP. USED Boonton 75A S8
TAKEN BY AH
REQUESTED BY RG

FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

ENGINEERING DATA

( ) T. CLASS
REMARKS Run # 5
CUSTOMER
GROUP

LOT No.	DE.	OP.	GR.	TYPE No.	CL.	TE.	COND.	DATE	ELAPSED TIME	SP.	SP.	

Signal Level 20 mV.

LOT No.	UNIT No.	Co pf.	RMR		Cop.	RMR			Cop.	RMR		
	01	1.08	>100		.99	100			1.24	12		
	02	1.00	100		.91	100			1.33	80		
	03	1.18	100	Good	.88	100			1.30	20		
	04	1.11	100		.99	100			1.18	50		
	05	1.12	100		.94	100			1.13	100		
	06	.88	50		1.10	100			.25	100		
	07	.88	6		1.41	50			1.02	100		
	08	.92	60		1.12	100			.25	100		
	09	.85	18		1.43	100			1.34	100		
	10	.94	80		1.27	4			1.28	100		
	11	1.00	50		1.20	100			1.41	100		
	12	.79	15		.24	100			.27	100		
	13	.93	50		1.15	3			1.34	16		
	14	.81	40		.23	100			1.37	1		
	15	.84	50		1.30	50			1.28	100		
	16	1.06	50		1.27	100			1.09	100		
	17	.91	30		1.29	1			1.31	80		
	18	.96	14		1.57	80			1.18	100		
	19	.87	35		1.03	100			.31	3		
	20	.94	50		1.28	100			1.21	100		
	21	1.06	50		1.26	100			1.06	100		
	22	.95	10		1.41	18			1.22	5		
	23	.64	100		.25	100			1.25	80		
	24	.92	9		1.01	100			1.33	20		
	25	1.22	100		1.03	100			1.16	5		
	26	.93	50		1.30	50			1.41	100		
	27	1.10	70		.28	1.5			.96	100		
	28	.78	30		1.24	100			1.32	50		
	29	.85	30		.31	0			1.33	50		
	30	1.06	100		1.31	100			1.05	80		
	31	.25	100		1.40	100			1.36	1		
	32	1.28	30		1.25	100			1.38	100		
	33	1.37	100		.27	100			1.32	100		
	34	1.27	1		1.20	2			1.45	100		
	35	1.30	50		.32	100			1.23	100		
	36	.17	>100		1.40	2			1.25	13		
	37	1.11	20		1.48	100			1.29	100		
	38	1.12	50		1.23	100			1.27	25		
	39	1.35	100		.25	1.5			1.11	100		
	40	.24	100		1.24	100			1.28	100		
	41	1.11	100		1.41	20			1.11	100		
	42	1.38	50		1.28	6			1.05	1		
	43	1.21	100		1.54	3			1.24	100		
	44	.28	100		1.13	18			1.29	100		
	45	1.28	40		1.27	100			1.12	90		
	46	1.38	60		1.23	100			1.05	20		
	47	1.08	80		1.34	100			1.11	100		
	48	1.26	100		1.21	100			1.06	50		
	49	.26	3		1.18	100			1.22	50		
	50	1.21	100		1.11	5			1.25	100		

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HARMONIC GENERATION AT MICROWAVE FREQUENCIES.

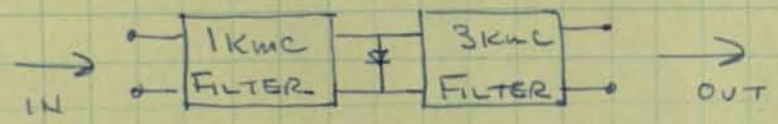
JOB # 141

WILL EVENTUALLY USE FAIRCHILD VARACTORS, WHEN AVAILABLE, FOR THE TIME BEING WILL PURCHASE SOME MICROWAVE ASSOCIATES DIODES AND ANY OTHERS THAT SEEM ~~ADE~~ USEFUL.

TO GET STARTED WILL CONSTRUCT A TRIPLER FROM 1000 mc TO 3000 mc. WILL ASSUME A 1.0 WATT SOURCE AT 1000 mc SINCE THIS SHOULD SOON BE POSSIBLE FROM SOLID STATE SOURCE.

DIODE SELECTION :-

1. DIODE WILL BE RESONATED IN SHUNT.



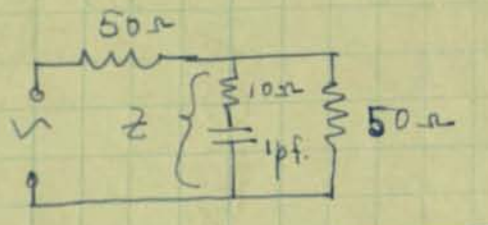
REASONS:

a. FILTERS CAN EASILY BE MADE TO LOOK LIKE OPEN CIRCUITS AT THE UNWANTED HARMONICS.

b. INPUT AND OUTPUT IMPEDANCES SHOULD BE ON THE ORDER OF 50Ω AND MORE EASILY WORKED WITH (T.E.M. TRANSMISSION LINES)

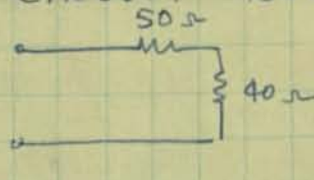
2. BREAK DOWN VOLTAGE REQUIRED

FOR POWER HANDLING CONSIDERATIONS CIRCUIT SHOULD LOOK SOMETHING LIKE:



$|Z| \cong 150\Omega.$

CIRCUIT BECOMES



$$V_{RMS} = \sqrt{P_{ave} \cdot R}, \quad P_{ave} = 1\text{ WATT.}$$

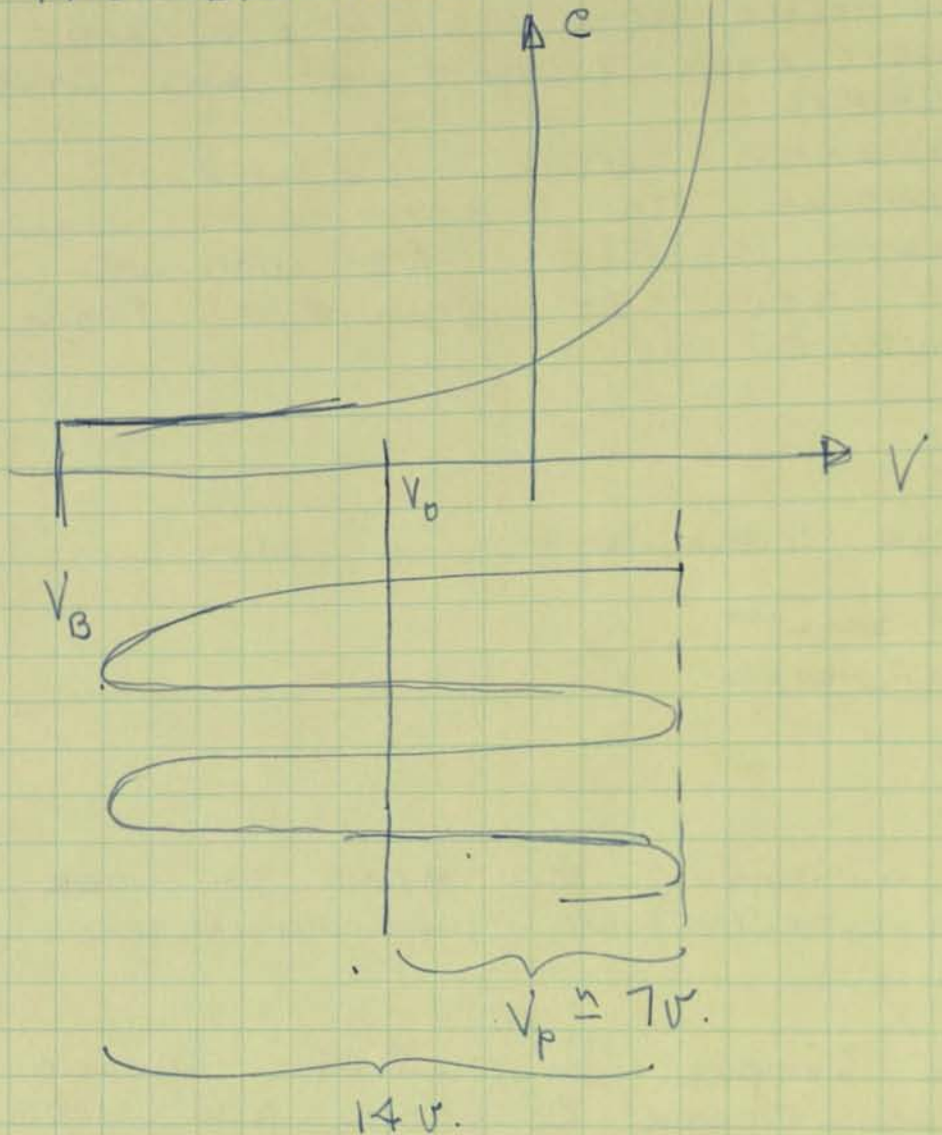
$$\frac{V_{peak}}{\sqrt{2}} = V_{RMS}$$

$$V_{RMS} = \sqrt{90} \cong 10V$$

$$V_{peak} \cong 14v, \quad \therefore \underset{\text{across diode}}{V_{peak}} \cong 7v$$

CONTINUED FROM P. 1.

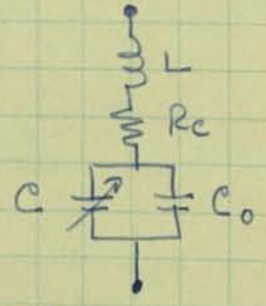
THEREFORE, A DIODE WITH BETTER THAN 14 V. BREAKDOWN IS NEEDED. CONSIDER C VS. V PLOT:



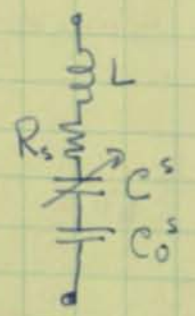
WILL TRY THE 24V. M.A. DIODE.

3. BARRIER CAPACITY REQUIRED FOR PROPER RESONANT FREQUENCY (OUTPUT)

EQUIVALENT CIRCUIT OF DIODE TO BE USED



CONSIDER



WOULD LIKE TO TUNE C_0^s WITH L.

LET US ASSUME $C_0 \simeq C_0^s$ WILL CHECK RESONANCE EXPERIMENTALLY ANYWAY.

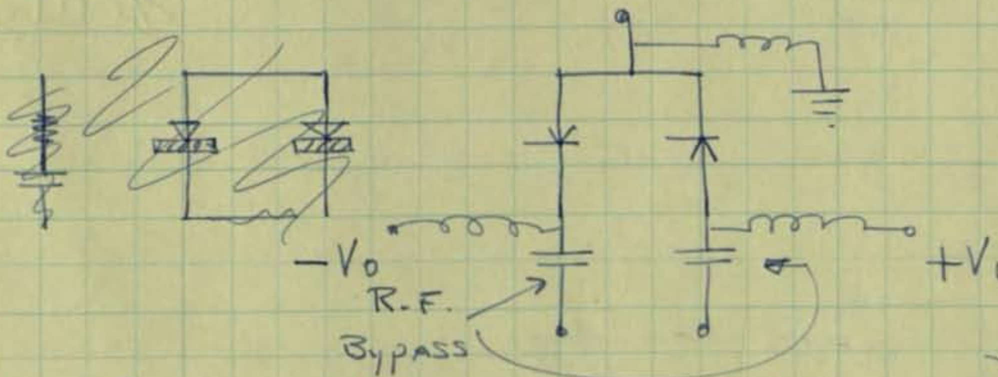
CONTINUED FROM p. 2

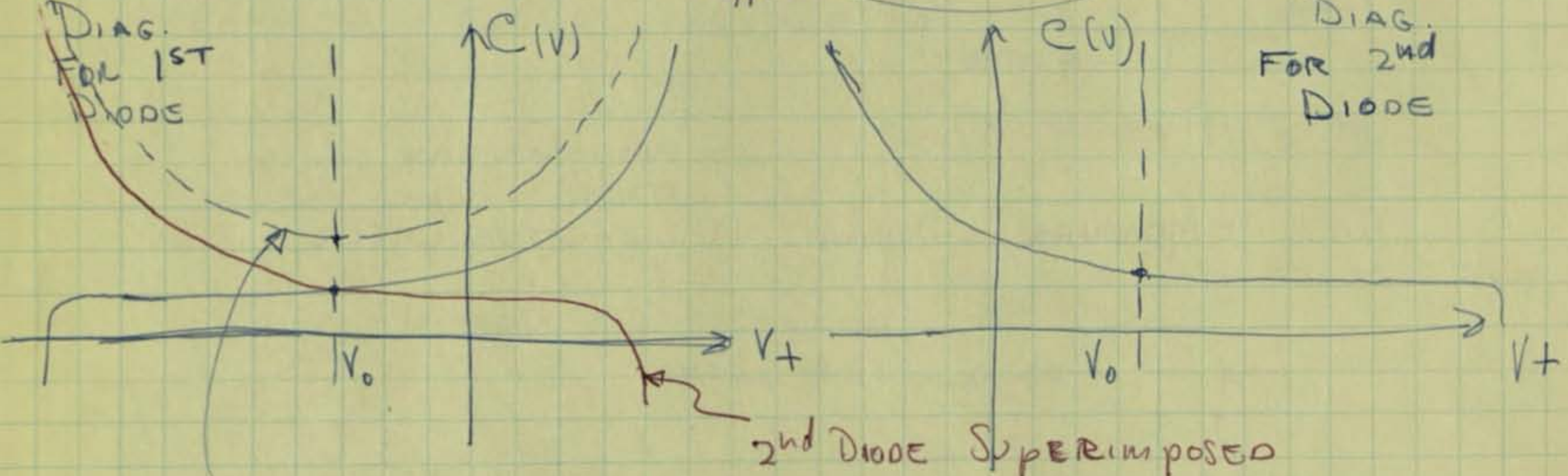
SET RESONANT FREQUENCY = 3 KMC.

$C_0 = \frac{1}{\omega^2 L}$, $L = .8 \times 10^{-9} h$ FROM M.A. CATALOG

$$C_0 = \frac{1}{(4\pi^2)(.8\times10^{-9})(9\times10^{18})} \cong 3.6 \text{ pf.}$$

ALSO, CONSIDER OPERATING A BALANCED PAIR OF DIODES.





ADDING TOGETHER GET ONLY EVEN HARMONICS

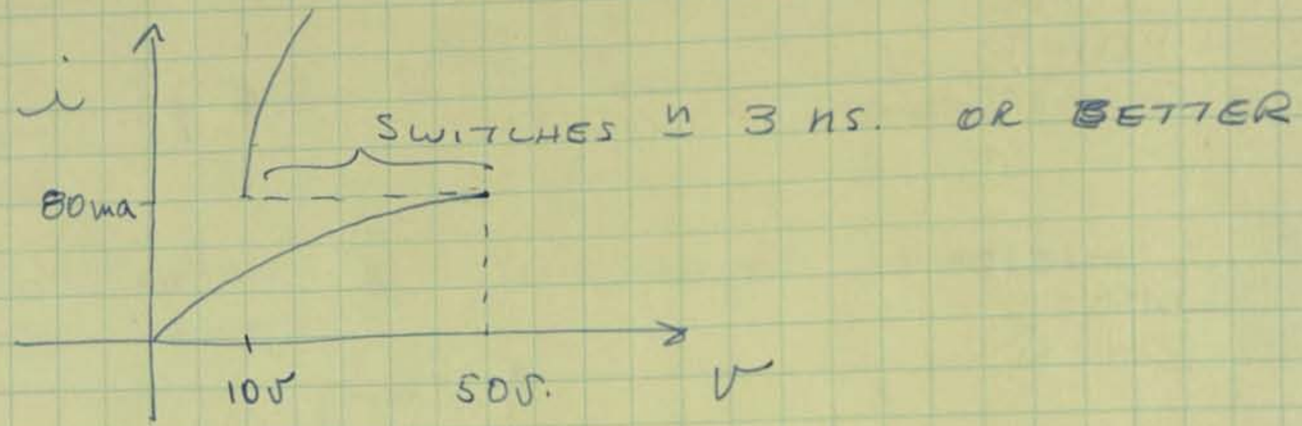
∴ ~~TH~~IS CIRCUIT WOULD PROVIDE A DOUBLER OR QUADRUPLER, ETC. ~~NEVERTHELESS, THE C's ARE IN PARALLEL & $C_0 \cong 1.8$ pf PER DIODE.~~

∴ THE MA ~~4334 C~~ ~~4354B~~ WITH AXIAL PRONG OR MA-4334-~~B~~C (PILL) ARE TO BE PURCHASED.

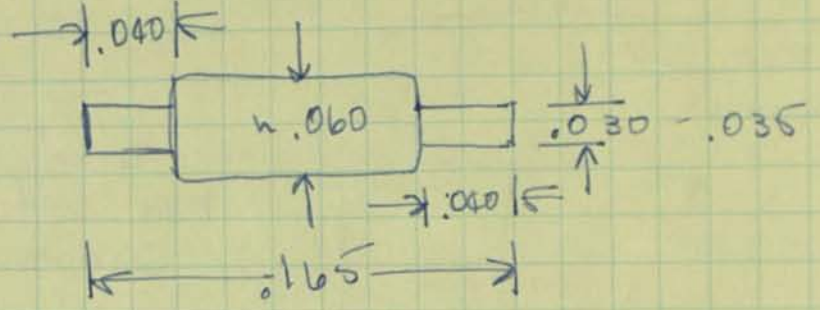
C_{min} in pf. = ~~[illegible]~~ .8 - 1.6, $R_{s_{max}}$ = ~~[illegible]~~ 3.5 Ω

NEGATIVE RESISTANCE DEVICE
DEVISED BY A. SAXENA.

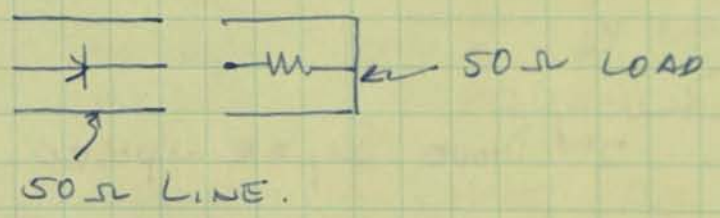
THE I.V. CURVE TAKEN ON BREADBOARD UNIT:



PACKAGE SIZE

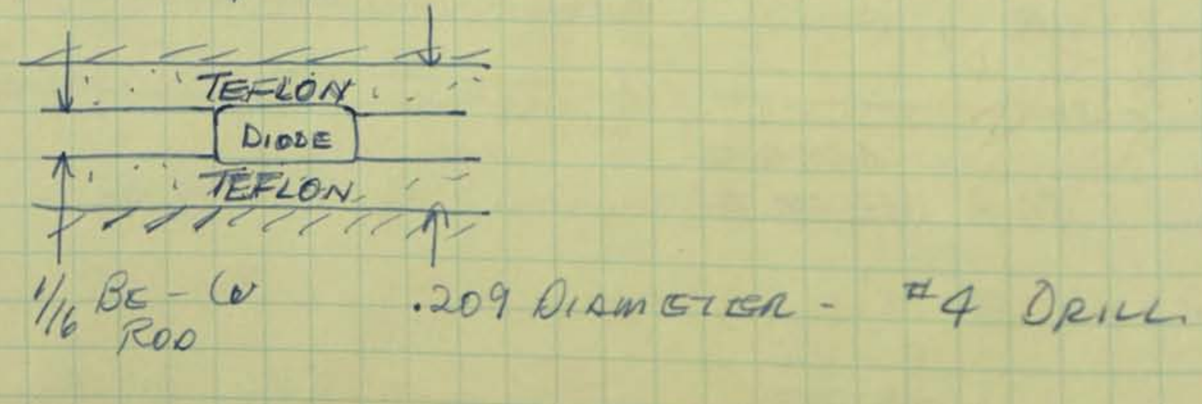


WILL MEASURE DIODE CHARACTERISTICS FIRST:



BIAS WILL PUT ON LINE PRECEDING SLOTTED
BY WAY OF A BIASER. (μ/AB)

GEOMETRY SHOULD BE SOMETHING LIKE:



CONTINUED FROM p. 3 2/1/62

SUBJECT: EFFICIENCY AND OPTIMUM MATCHING CONDITIONS.

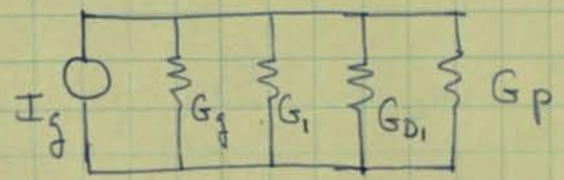
REFERENCE: JOHNSON: LARGE SIGNAL ANALYSIS OF A PARAMETRIC HARM. GENERATOR. PGMTT - SEPT. 60

$$\eta = 2\frac{G_L G_g}{G_{T_1} G_{T_2}} \frac{100}{\left[1 + \frac{(n\omega_1 C_0 b_n)^2}{2 G_{T_1} G_{T_2}} + \frac{G_{T_1} G_{T_2}}{2(n\omega_1 C_0 b_n)^2}\right]}$$

η - EFFICIENCY IN %

$G_{T_1} = G_1 + G_{D_1} + G_g$

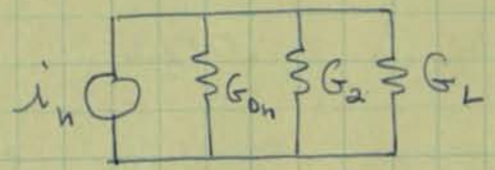
$G_{T_2} = G_2 + G_{Dn} + G_L$



INPUT CIRCUIT

G_1 & G_2 ARE CIRCUIT LOSSES LET $G_1 = G_2 = 0$ FOR THE TIME BEING.

w_1 - RADIAN MEASURE INPUT FREQ.



OUTPUT CIRCUIT FOR n^{th} HARM.

G_{D_1} - DIODE CONDUCTANCE AT ω_1.

G_{Dn} - " " " ω_n.

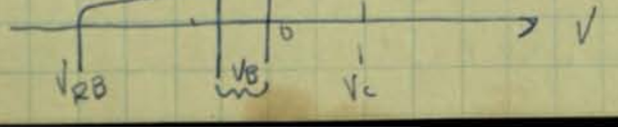
G_g - INPUT CONDUCTANCE.

G_L - OUTPUT " .

C_0 - OPERATING POINT CAPACITY.

$b_n = \frac{a_n}{C_0 V_1}$, where $q = \frac{a_0}{2} + \sum_{n=1}^{\infty} a_n \cos(n\omega_1 t - \psi_n)$

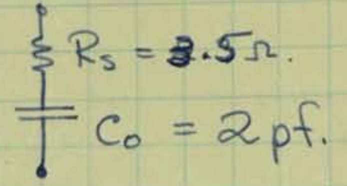
& $V = V_B + V_1 \cos \omega_1 t + V_n \cos(n\omega_1 t + \phi_n)$ - VOLT. ACROSS DIODE. (TOTAL)



CONT. FROM p.5 2/2/62

LET US SELECT $G_g = G_L = G$
AND ALSO CONSIDER VALUES OF G_{D_1} & G_{D_n}

AT OPERATING POINT (D.C. BIAS POINT) DIODE LOOKS LIKE:



$$Z = 3.5 - j\frac{1}{\omega C} = R_s - jX_{C_o}$$

$$Y = \frac{1}{Z} = \frac{1}{R_s - jX_{C_o}} \times \frac{R_s + jX_{C_o}}{R_s + jX_{C_o}} = \frac{R_s}{R_s^2 + X_{C_o}^2} + j\frac{X_{C_o}}{R_s^2 + X_{C_o}^2}$$

$$\therefore G_D = \frac{R_s}{R_s^2 + X_{C_o}^2} = \frac{3.5}{12.2 + \left(\frac{1}{\omega\, 2\times10^{-12}}\right)^2}$$

IF $\omega_1 = 2\pi\, 10^9$, $f_1 = 1000$ mc

$$\omega_1 C_o = .0125, \quad \frac{1}{\omega_1 C_o} = 80, \quad \left(\frac{1}{\omega_1 C_o}\right)^2 = 6400$$

$$\text{\&}\ G_{D_{1kmc}} = \frac{3.5}{6412} = \underline{5.47 \times 10^{-4}}$$

$\underline{4.55 \times 10^{-3}}$

IF $W_2 = 2\pi(2\times10^9)$

$$\frac{1}{W_2 C_o} = 40, \quad \left(\frac{1}{W_2 C_o}\right)^2 = 1600$$

$$G_{D_{2kmc}} = \frac{3.5}{12.2 + 1600} = \frac{3.5}{1612} = \underline{2.18 \times 10^{-3}}$$

LET US ASSUME $G_{D_{1kmc}} = G_{2kmc} = \underline{1.5 \times 10^{-3}\ \mho}$

$\therefore G_{T_1} = G_{T_2} = G_T$

NOW $$\eta = \frac{2G^2}{G_T^2}\ \frac{100}{\left[1 + \frac{K}{2G_T^2} + \frac{G_T^2}{2K}\right]}$$

WHERE $K = (n\omega_1 C_o b_n)^2$

CONT. FROM p. 6 2/2/62

$$\eta = 400\,K \frac{G^2}{(G_T^2+K)^2}, \quad G_T = G_D + G$$

NOW TO MAXIMIZE η TO GET G.

$$\frac{d\eta}{dG} = 400K \left\{ \frac{(G_T^2+K)^2 2G - G^2 2(G_T^2+K) 2G_T \frac{dG_T}{dG}}{(G_T^2+K)^4} \right\}$$

SINCE $\frac{dG_T}{dG} = 1$ & SETTING $= 0$

$$(G_T^2+K)^2 2G - 4G^2G_T(G_T^2+K) = 0$$

TRIVIAL SOLUTIONS ARE:

$$G = 0, \quad G_T^2 + K = 0 \text{ OR } G_T^2 = -K, \quad K \geq 0$$

LEAVING:

$$2(G_T^2+K) - 4G_TG = 0$$

$$G_D^2 + \cancel{2GG_D} + G^2 + K - \cancel{2GG_D} + 2G^2 = 0$$

$$G_D^2 - G^2 + K = 0$$

$$\text{OR} \quad G = \sqrt{G_D^2 + (n\omega_1 C_o b_n)^2}$$

FROM JOHNSON $b_2 \cong .2$ FOR MAX. SWING OF INPUT VOLTAGE

$$\therefore n\omega_1 C_o b_n = (2)(.0125)(.2) = 5.0 \times 10^{-3}$$

$$(n\omega_1 C_o b_n)^2 = 25.0 \times 10^{-6}$$

$$\& \quad G_D^2 = 2.3 \times 10^{-6}$$

$$\therefore G = 10^{-3}\sqrt{27.3} = 5.22 \times 10^{-3} \mho$$

$$\left(R = \frac{1}{G} \cong 191\Omega\right)$$

$$\begin{array}{r} 5.22 \\ 1.50 \\ \hline 6.72 \end{array}$$

$G_T = 6.72 \times 10^{-3}$

$G_T^2 = 45 \times 10^{-6}$

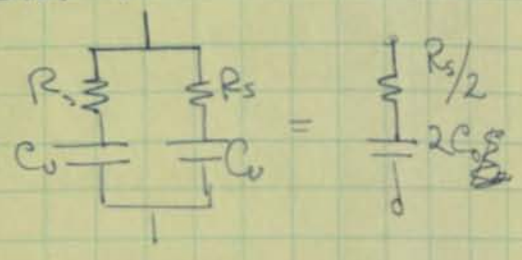
CONT. FROM P. 7 2/2/62

CALCULATING η

$$\eta = 400 \frac{(25.0 \times 10^{-6})(27.3 \times 10^{-6})}{(45 \times 10^{-6} + 25 \times 10^{-6})^2}$$

$$= 400 \frac{(25.0)(27.3)}{(70)^2} \cong 55\%$$

CONSIDER BALANCED SYSTEM!



THEN $K = 100 \times 10^{-6}$

G_D WOULD STAY ABOUT THE SAME

$G = \sqrt{100 \times 10^{-6}}$

$G \cong .010$

& $R = \frac{1}{G} \cong \underline{100\,\Omega}$

$G_T = G + G_D \cong 10 \times 10^{-3} + 1.5 \times 10^{-3}$

$\doteq 11.5 \times 10^{-3}$

$G_T^2 = 132 \times 10^{-6}$

$$\eta = 400 \frac{(102 \times 10^{-6})(100 \times 10^{-6})}{(132 \times 10^{-6} + 100 \times 10^{-6})^2}$$

$$\eta = 400 \frac{(102)(100)}{(132+100)^2} = \frac{(400)(10200)}{(232)^2} \cong 75\%$$

~~IT APPEARS BALANCED SYSTEM MORE EFFICIENT~~

ERROR! $G_D \cong 3 \times 10^{-3}$, $G_D^2 = 9 \times 10^{-6}$

$G = \sqrt{9 \times 10^{-6} + 100 \times 10^{-6}} = 10.4 \times 10^{-3}$

$G_T = G + G_D = 13.4 \times 10^{-3}$

$G_T^2 \cong 180 \times 10^{-6}$

$$\eta = 400 \frac{K\ G^2}{(G_T^2+K)^2} = \frac{(400)(100\times10^{-6})(109\times10^{-6})}{(180\times10^{-6}+100\times10^{-6})^2}$$

$\eta \cong 55\%$

∴ EFFICIENCY SHOULD BE SAME.

& $R_{in} = \frac{1}{109} \simeq 96\Omega$

CHECKING AGAINST JOHNSONS CURVES - FIG. 7.
SHOWING Q_{D1} VS. INSERTION LOSS

$$Q_{D1} = \frac{\omega_1 C_0}{G_{D1}} = \frac{2\pi 10^9\ \ 2\times10^{-12}}{.55\times10^{-3}}$$

$Q_{D1} \simeq 25$

WHICH GIVES A LOSS OF ABOUT 3db. - 4db.

NOW CONSIDER REACTIVE PORTION OF ~~G~~ Y, NAMELY

$jB = j\frac{X_{c0}}{R_s^2+X_{c0}^2}$. THIS HAS NOT BEEN CONSIDERED IN THE CIRCUIT & ∴ MUST BE TUNED OUT.

CALCULATION OF REACTANCE IN THE .5 - 2.0 KMC RANGE.

AT 1KMC. $\omega_1 C_0 = .0125$, $\frac{1}{\omega_1 C_0} = 80$

$$jB = j\frac{80}{3.5^2+6400} = \frac{80}{12+6400}$$ → FOR SINGLE ENDED SYSTEM

FOR DOUBLE ENDED SYSTEM

$$jB = j\frac{40}{(1.75)^2+(160)^2}$$

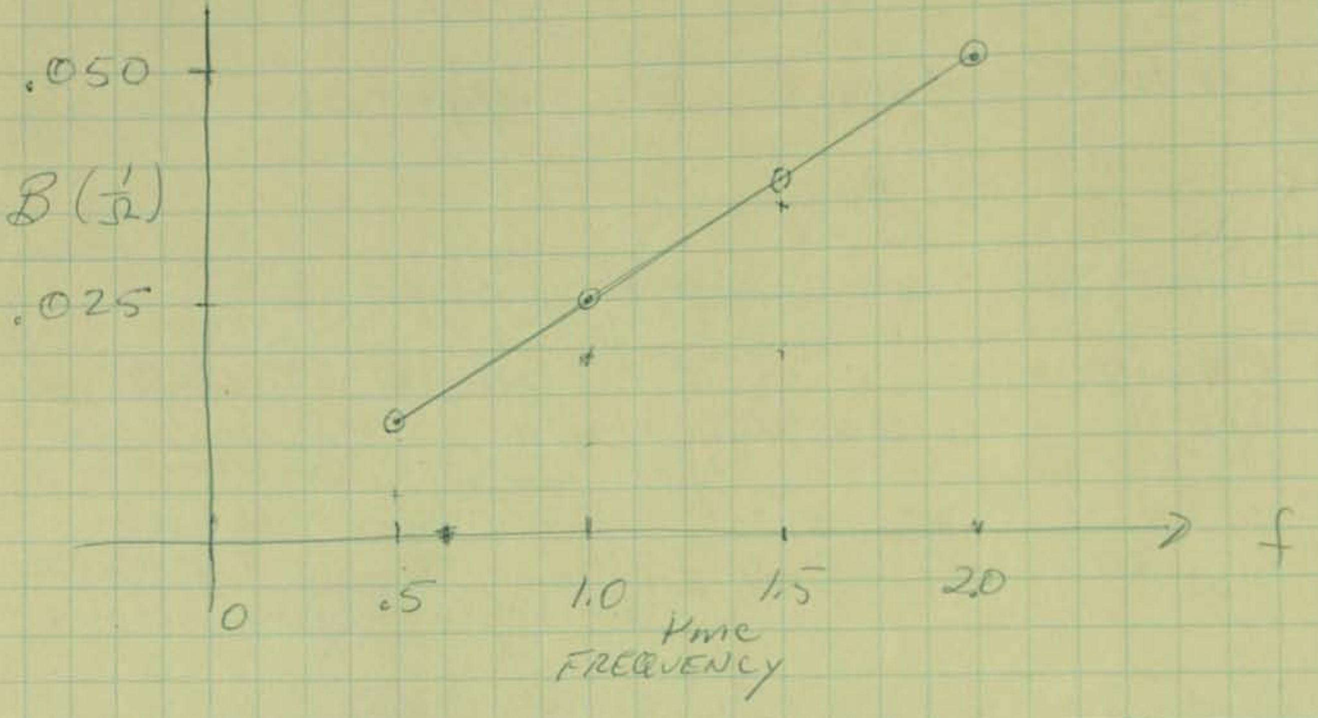
∴ WILL NEGLECT R_s^2 & $jB = j\omega 2C_0$ FOR BALANCED SYSTEM

10 CONT. FROM p. 9 2/5/62

$B = 4\pi f C_0$; TAKING $C_0 = 2\times10^{-12}$ far. & f IN KMC.

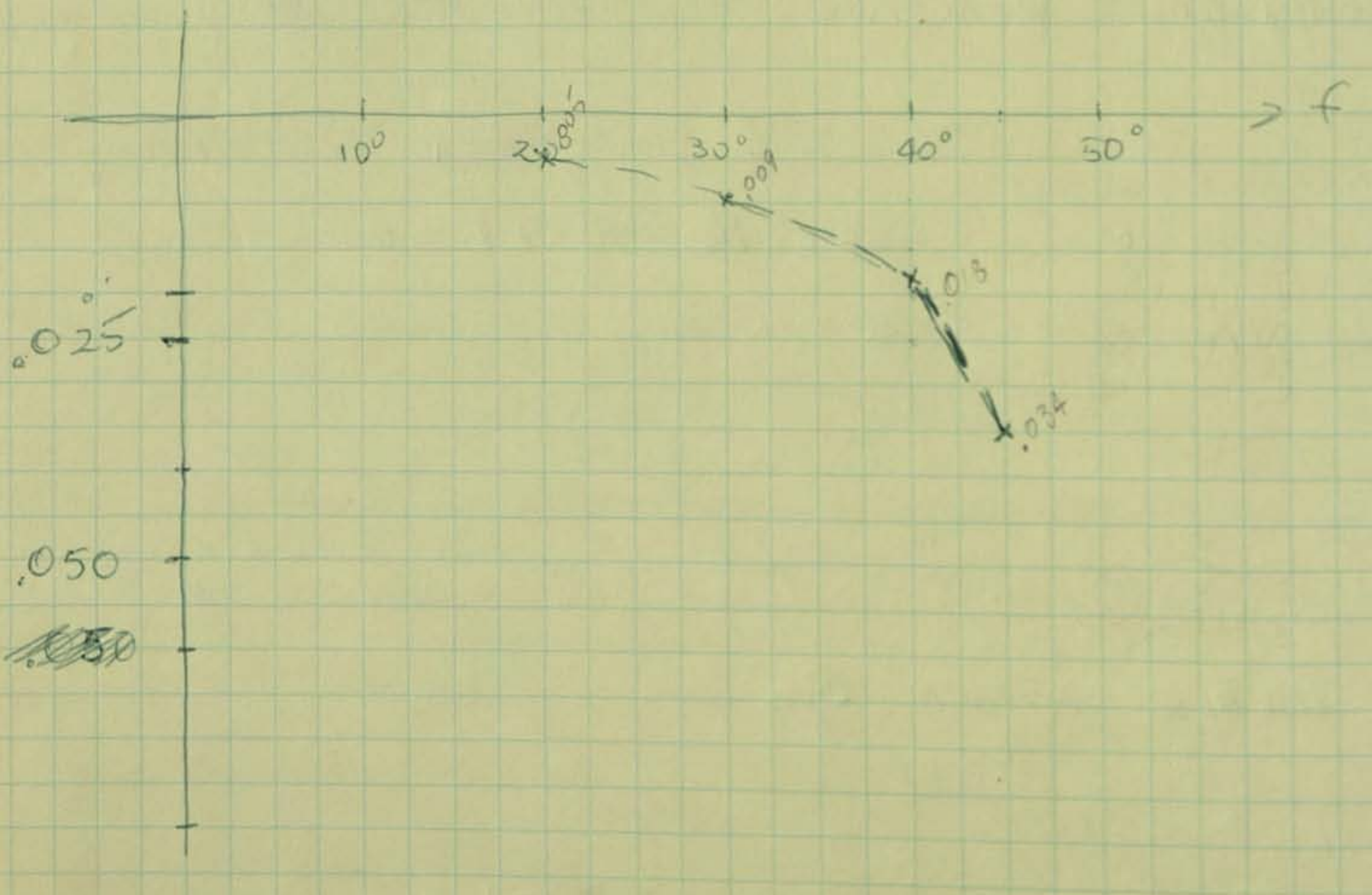
$B = 8\pi f_{kmc} \times 10^{-3}$ ℧.

$B. = .025 f_{kmc}$.



FROM COMPENSATED FILTER PLOTS

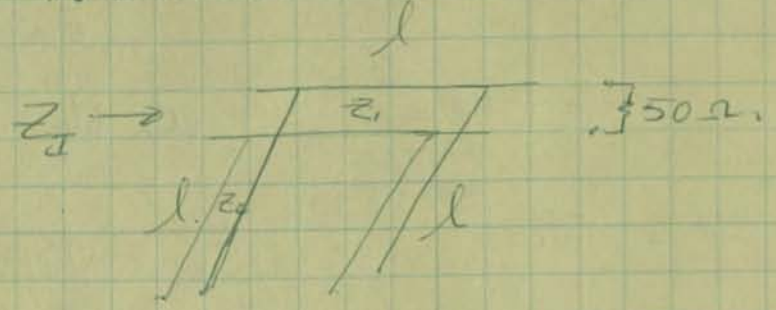
UNNORMALIZED ~~TO 100Ω IMAGE IMPEDANCE~~



CONT. FROM p. 10

WILL GO AHEAD AND CONSTRUCT 50Ω IMAGE FILTER. WANT STOPBAND CENTER AT 3.0 KMC. AND CUTOFF AT ~~2~~ 1.6 KMC.

LET $\rho = 1 = \frac{Z_1}{Z_2}$



$Z_{I_0} = 50 = \frac{Z_1}{\sqrt{3}}$

$Z_1 = 86.5\,\Omega = Z_2$

USING REXOLITE #1422 $\sqrt{\epsilon_r} = 1.60$

$\therefore \sqrt{\epsilon_r}\, Z_1 \doteq 138\,\Omega$, $t/b = \frac{.003}{.25} = .012$

$\therefore \frac{w}{b} = .25$, $b = \frac{1}{4}$

$w = \frac{.25}{4} \cong .063$

$\ell = \frac{\lambda}{4}$ @ 3KMC. $= \frac{3\times10^{10}}{(4)(1.6)(3\times10^9)(2.54)} = .615$

THIS GIVES A $f_c = 2$ KMC. ~~WHICH WILL~~ BE O.K. TO START WITH.

FOR 50Ω LINE $30\sqrt{\epsilon_r} = 80\,\Omega$, $\frac{w}{b} = .72$

$w = .180$

CORRECTION

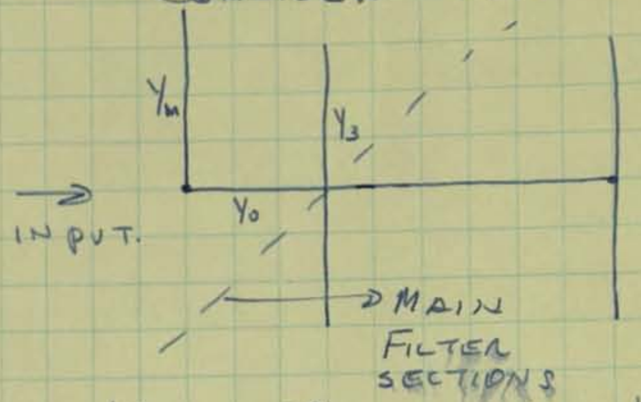
DESIRE TO STOP 1 KMC.

FROM VALUES SHOWN ON p. 10 IT LOOKS MORE ADVANTAGEOUS TO START WITH 500MC AND MULTIPLY TO 1000MC

CONTINUED FROM p. 11

2/20/62

CONSIDER END MATCHING FOR FILTER



$y_3 = \frac{1}{56\Omega}$, $y_0 = \frac{1}{102\Omega}$.

$Z_3 = 56\Omega$, $Z_0 = 102\Omega$.

$\sqrt{\epsilon_r}\ 56 =$ ~~163 Ω~~ 89.5Ω. $\sqrt{\epsilon_r}\ 102 = 163\Omega$

$\frac{w_3}{b} = .59$ $\frac{w_0}{b} = .155$

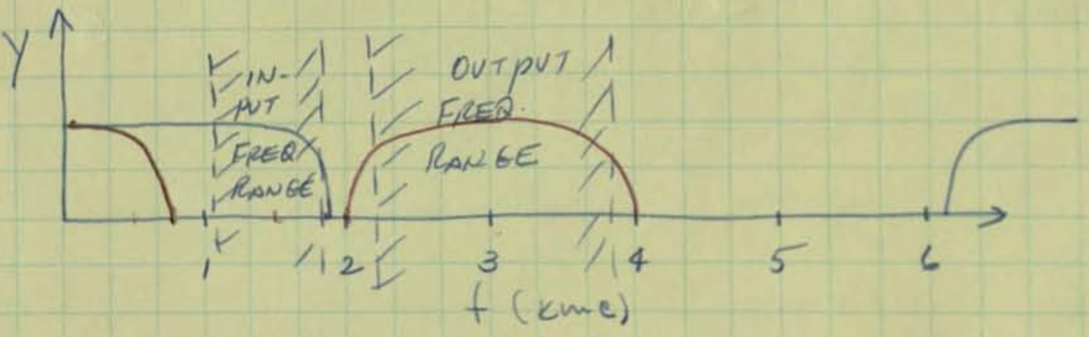
$w_3 = .147$ $w_0 = .039$

Y_m FROM PREVIOUS DESIGN $w_m \hat{=} .045$

LENGTH $\ell = .600$ FOR $f_c = 4.0$ Kmc

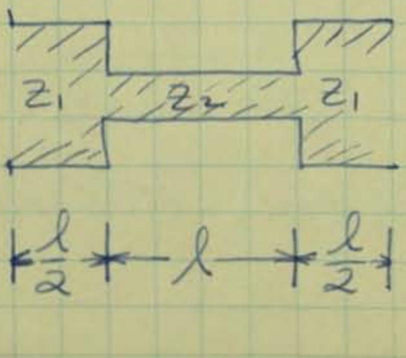
$$\frac{4.0}{1.6} = \frac{x}{.460} \quad , \; x = 1.15''$$

OUTPUT FILTER DESIGN (IN RED)



WILL CENTER AT 3 Kmc - SHOULD BE SELF RESONANT FREQ. OF DIODE

TYPE OF FILTER SECTION:



ϕ ~ π @ 3kmc

$$A = -K + (1+K)\cos^2\phi$$

$$-1 = -K + (1+K)\cos^2 120°$$

$\frac{180}{\phi_c} = \frac{3}{2}$

$$\cos 120° = -\cos 60° = -\frac{1}{2}$$

$\phi_c = 120°$

$$\therefore -1 = -K + \frac{1+K}{4}$$

WHERE $K = \frac{1}{2}\left(\frac{Z_1}{Z_2} + \frac{Z_2}{Z_1}\right)$

CONT. FROM p. 12 2/20/62

$-4 = -4K + 1 + K$

$3K = 5$, $K = 5/3$

& $\frac{10}{3} = \frac{Z_1}{Z_2} + \frac{Z_2}{Z_1}$ ALSO $50 = \sqrt{Z_1 Z_2}$

$\frac{10}{3} = x + \frac{1}{x}$ OR $2500 = Z_1 Z_2$

$x^2 - \frac{10}{3} x + 1 = 0$

$$x = \frac{10/3 \pm \sqrt{\frac{100}{9} - 4}}{2} = \frac{5}{3} \pm \frac{4}{3}$$

$x = 3$ or $\frac{1}{3}$, SINCE $Z_2 > Z_1$

$x = \frac{Z_1}{Z_2} = \frac{1}{3}$, $Z_2 = 3 Z_1$

& $2500 = 3 Z_1^2$, $Z_1 = \frac{50}{\sqrt{3}}$

$$\boxed{\begin{aligned} Z_1 &= 28.9\,\Omega \\ Z_2 &= 86.7\,\Omega \end{aligned}}$$

WITH $\sqrt{\epsilon_r} = 1.6$ & $t/b = .012$

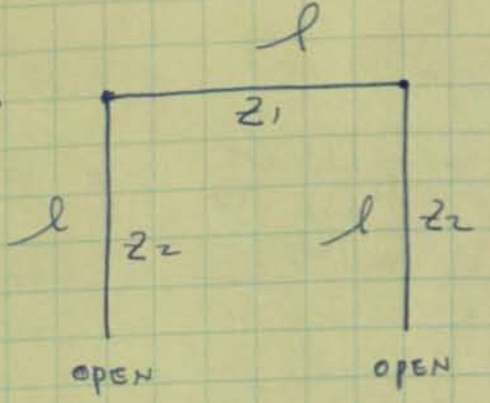
$\sqrt{\epsilon_r}\, Z_1 = 46.2$ $w_1/b = 1.55$ $w_1 = .388$

$\sqrt{\epsilon}\, Z_2 = 139.0$ $w_2/b = .23$ $w_2 = .058$

$$l = \frac{1}{4} \frac{3 \times 10^{10}}{(1.6)(\cancel{3\times}1.5 \times 10^9)\, 2.54} = 1.23''$$

CONT. FROM p. 13

CONSIDER ANOTHER FILTER:



$$\mathcal{C} = j\,\frac{\sin\phi}{Z_1}\left[1+\rho\left(2-\rho\tan^2\phi\right)\right]$$

$$\mathcal{B} = j\,Z_1 \sin\phi$$

$$Y_I = \pm\sqrt{\frac{\mathcal{C}}{\mathcal{B}}} = \pm\sqrt{\frac{1+\rho(2-\rho\tan^2\phi)}{Z_1^2}}$$

or $\dfrac{Y_I}{Y_1} = \pm\sqrt{1+\rho(2-\rho\tan^2\phi)}$, $\rho = \dfrac{Z_1}{Z_2} = \dfrac{Y_2}{Y_1}$

$$A = (1+\rho)\cos\phi - \frac{\rho}{\cos\phi}$$

at cutoff $A = +1$ ie USING 1^{ST} HARMONIC PASS BAND :- ALSO $\phi_{c_2} \sim \overset{2}{\cancel{4}}$ KMC. & $\phi_{180^\circ} \sim$ 3KMC

$$\frac{180^\circ}{\phi_{c_2}} = \frac{3}{2}\ , \quad \phi_{c_2} = 120^\circ$$

$$\cos 120^\circ = -\cos 60^\circ = -\tfrac{1}{2}$$

$$1 = (1+\rho)\left(-\tfrac{1}{2}\right) + 2\rho$$

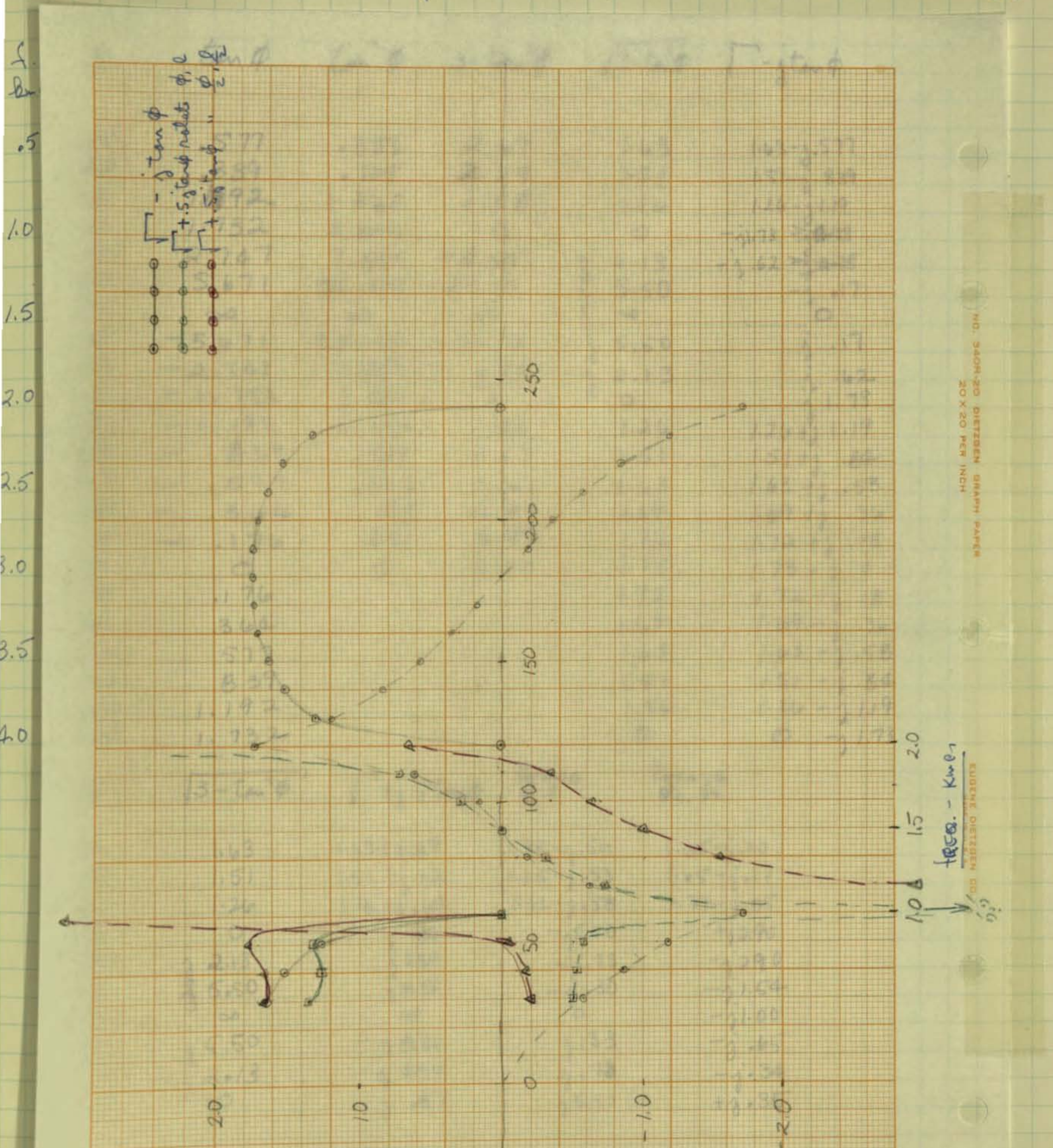
$$2 = -1-\rho+4\rho\ ,\quad 3\rho = 3\ ,\quad \rho = 1\ ,\quad Z_1 = Z_2 = Z$$

$$\therefore\ \frac{Y_I}{Y_1} = \pm\sqrt{3-\tan^2\phi}$$

ON FOLLOWING PAGE WILL PLOT $\frac{Y_I}{Y_1}$ VS. ϕ

WHERE
$180^\circ \sim$ 3 KMC.
$120^\circ \sim$ 2 KMC.
$80^\circ \sim$ 1.5 KMC.
$60^\circ \sim$ 1.0 KMC.
$30^\circ \sim$ .5 KMC.

CONT. FROM p. 14

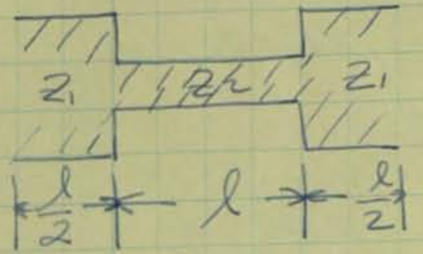


CONT. FROM p. 14

f. bre.	φ (°)	$\tan\phi$	$\tan^2\phi$	$3-\tan^2\phi$	$\sqrt{3-\tan^2\phi}$	$\sqrt{\ } - j\tan\phi$
.5	30°	.577	.333	2.67	1.63	1.63 - j.577
	40°	.839	.705	2.29	1.51	1.51 - j.839
	50	1.192	1.420	1.58	1.26	1.26 - j1.19
1.0	60	1.732	3.000	0	0	-j1.73 ~~j1.73~~
	70	2.747	7.550	-4.55	j 2.13	-j.62 ~~j2.75~~
	80	5.671	32.100	-29.10	j 5.50	-j .17
1.5	90	∞	∞	-∞	-j ∞	0
	100	-5.671	32.100	-29.10	-j 5.50	j .17
	110	-2.747	7.550	- 4.55	-j 2.13	j .62
2.0	120	-1.732	3.000	0	0	j 1.73
	130	-1.192	1.420	1.58	1.26	1.26 + j 1.19
	140	- .839	.705	2.29	1.51	1.51 + j .84
2.5	150	- .577	.333	2.67	1.63	1.63 + j .58
	160	- .364	.133	2.87	1.69	1.69 + j .36
	170	- .176	.031	2.97	1.72	1.72 + j .18
3.0	180	0	0	3.00	1.73	1.73 + j 0
	190	.176			1.72	1.72 - j .18
	200	.364			1.69	1.69 - j .36
3.5	210	577			1.63	1.63 - j .58
	220	839			1.51	1.51 - j .84
	230	1.192			1.26	1.26 - j 1.19
4.0	240	1.732			0	0 - j 1.73

φ	$\sqrt{3-\tan^2\phi}$	$\sqrt{\ } + j.5\tan\phi$	ROTATE φ, l	ROTATE φ/2, l/2
30	1.63	1.63 + j.29	1.35 - j.50	1.65 - j.20
40	1.51	1.51 + j.42	1.25 - j.53	1.65 - j.17
50	1.26	1.26 + j.60	1.32 - j.58	1.77 - j.05
60	0	j .86	-j5.50	+j2.90
70	j 2.13	j 3.50	-j .73	-j 2.90
80	j 5.50	j 8.33	-j .30	-j 1.54
90	∞	∞	0	-j 1.00
100	- j 5.50	- j 8.33	j .33	-j .65
110	- j 2.13	- j 3.50	j .78	-j .34
120	0	- j .87	j 5.50	+j .35

MORE FILTERS - SEE p. 12 3/2/62



$$B = jZ_1 \sin\phi \cos\phi + \frac{j}{2Z_2}\left[Z_2^2 - Z_1^2 + (Z_2^2+Z_1^2)\cos\phi\right]\sin\phi$$

$$C = \frac{j}{Z_1}\sin\phi\cos\phi + \frac{j}{2Z_1^2Z_2}\left[Z_1^2 - Z_2^2 + (Z_1^2+Z_2^2)\cos\phi\right]\sin\phi$$

$$Y_I^2 = \frac{\frac{\cos\phi}{Z_1} + \frac{Z_1^2 - Z_2^2 + (Z_1^2+Z_2^2)\cos\phi}{2Z_1^2Z_2}}{Z_1\cos\phi + \frac{Z_2^2 - Z_1^2 + (Z_2^2+Z_1^2)\cos\phi}{2Z_2}} = \frac{C}{B}$$

$$= Y_1^2 \frac{\frac{\cos\phi}{Y_1} + \frac{Y_2}{2}\left[Z_1^2 - Z_2^2 + (Z_1^2+Z_2^2)\cos\phi\right]}{\frac{\cos\phi}{Y_1} + \frac{Y_2}{2}\left[Z_2^2 - Z_1^2 + (Z_2^2+Z_1^2)\cos\phi\right]}$$

$$= Y_1^2 \frac{\cos\phi\left(\frac{1}{Y_1} + \frac{Y_1^2+Y_2^2}{2Y_1^2Y_2}\right) + \frac{Y_2^2-Y_1^2}{2Y_1^2Y_2}}{\cos\phi\left(\frac{1}{Y_1} + \frac{Y_1^2+Y_2^2}{2Y_1^2Y_2}\right) + \frac{Y_1^2-Y_2^2}{2Y_1^2Y_2}}$$

$$= Y_1^2 \frac{\cos\phi\,(Y_1+Y_2)^2 + (Y_2+Y_1)(Y_2-Y_1)}{\cos\phi\,(Y_1+Y_2)^2 + (Y_1+Y_2)(Y_1-Y_2)}$$

DIVIDING OUT Y_2+Y_1

$$Y_I^2 = Y_1^2 \frac{(Y_1+Y_2)\cos\phi + Y_2 - Y_1}{(Y_1+Y_2)\cos\phi + Y_1 - Y_2} = Y_1^2 \frac{\left(\frac{Y_1}{Y_2}+1\right)\cos\phi + \left(1-\frac{Y_1}{Y_2}\right)}{\left(\frac{Y_1}{Y_2}+1\right)\cos\phi - \left(1-\frac{Y_1}{Y_2}\right)}$$

LETTING $\frac{Y_1}{Y_2} = \rho$

$$\boxed{\frac{Y_I}{Y_1} = \pm\sqrt{\frac{(1+\rho)\cos\phi + (1-\rho)}{(1+\rho)\cos\phi - (1-\rho)}}}$$

$$\left\{\begin{array}{l} \text{LET } \rho = 3 = \frac{Y_1}{Y_2} = \frac{Z_2}{Z_1} \\ \\ \frac{Y_I}{Y_1} = \sqrt{\frac{2\cos\phi - 1}{2\cos\phi + 1}} \end{array}\right\} \text{SPECIAL CASE.}$$

CONT. FROM p. 16 3/7/62

AT ZERO FREQ. OR $\phi = 0$

$$\frac{Y_{I_0}}{\cancel{Y_1}} = \pm Y_1 \sqrt{\frac{(1+\rho) + (1-\rho)}{(1+\rho) - (1-\rho)}} = \pm Y_1 \sqrt{\frac{2}{2\rho}}$$

$$Y_{I_0} = Y_1 \sqrt{\frac{1}{\rho}}$$

at FIRST PASS BAND $\phi = 180°$

$$Y_I \Big|_{\phi = 180°} = Y_1 \sqrt{\frac{-(1+\rho) + 1 - \rho}{-(1+\rho) - 1 + \rho}} = Y_1 \sqrt{\frac{-2\rho}{-2}}$$

$$Y_I \Big|_{\phi = 180°} = Y_1 \sqrt{\rho}$$

FOR THE CASE OF $\rho = 3$

PLOT Y_I/Y_1

~~ALSO DESIRE~~ Y

NORMALIZE WITH RESPECT TO Y_1

ϕ (°)	$\cos\phi$	$2\cos\phi$	$(2\cos\phi - 1)$	$(2\cos\phi + 1)$	$\frac{2\cos\phi - 1}{2\cos\phi + 1}$	$\sqrt{\frac{2\cos\phi - 1}{2\cos\phi + 1}}$	$.044\sqrt{\ }$	ROTATE $\theta/2$ A
50	.642	1.284	.284	2.284	.124	.352	.0155	.42 − j.40
60	.500	1.000	0	2.000	0	0	0	−j.58
70	.342	.684	−.316	1.684	−.187	j.432	j.0190	−j.20
80	.174	.348	−.616	1.384	−.445	j.667	j.0294	−j.11
90	0	0	−1.000	1.000	−1.000	j1.000	j.044	0
100	−.174	−.348	−1.384	.616	−2.25	j1.50	j.066	j.11
110	−.342	−.684	−1.684	.316	−5.33	j2.31	j.102	j.20
120	−.500	−1.000	−2.000	0	∞	∞	∞	j.57
125	−.574	−1.148	−2.148	−.148	14.52	3.91	.172	.32 + j.48
130	−.642	−1.284	−2.284	−.284	8.05	2.84	.125	.41 + j.47
140	−.766	−1.532	−2.532	−.532	4.75	2.18	.096	.50 + j.37
150	−.866	−1.732	−2.732	−.732	3.73	1.93	.085	.54 + j.20
160	−.940	−1.880	−2.880	−.880	3.27	1.81	.080	.56 + j.12
170	−.985	−1.970	−2.970	−.970	3.06	1.75	.077	.57 + j.06
180	−1.00	−2.000	−3.000	−1.000	3.00	1.73	.075	.57 + j0

$Z_I \Big|_{\phi = 180°} = \frac{Z_1}{\sqrt{\rho}}$, LET $Z_I \Big|_{180°} = 10\,\Omega$

& $\rho = 5$, $\sqrt{\rho} = 2.24$, $\therefore Z_1 = 22.4\,\Omega$., & $Z_2 = 112\,\Omega$.

$\therefore Y_1 = \frac{1}{22.4} = .044$

CONT. FROM p. 17 3/7/62

$Z_1 = 22.4\Omega, \quad Z_2 = 112\ \Omega$

$\sqrt{\epsilon_r}\, Z_1 = 36\Omega. \quad , \sqrt{\epsilon_r}\, Z_2 = 179\Omega.$ USING REX #1422

$\frac{w_1}{b} = 2.1 \qquad \frac{w_2}{b} = .11 \qquad , b = \frac{1}{4}$

$w_1 = .525 \qquad w_2 = .028$

$w_2 \simeq .025$

From p. 13 make $l = 1.25''$

NOW CONSIDER TRANSFORMER FROM 10Ω TO 50Ω.

FROM COHN'S PAPER

$$\phi_1 = \frac{180^\circ}{1+p}, \quad p = \frac{f_2}{f_1} = 2$$

$$\phi_1 = 60^\circ, \quad \cos\phi_1 = .5, \quad \frac{1}{\cos\phi_1} = 2$$

TAKE $S_{max} = 1.10$ (MAX. VSWR)

SOLVING FOR n

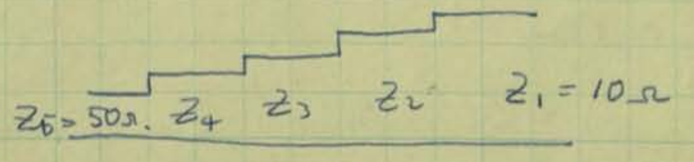
$$T_{n-1}\left[\frac{~~\cos\phi~~ 1}{\cos\phi_1}\right] = \left[\frac{S_{max} - 1}{\ln\left[\frac{Z_{n+1}}{Z_1}\right]}\right]^{-1} = \frac{\ln\left[\frac{Z_{n+1}}{Z_1}\right]}{S_{max} - 1}$$

$$\therefore T_{n-1}[2] = \frac{\ln 5}{.10} = \frac{1.61}{.10} = 16.1$$

$$T_3[2] = 4\cdot 2^3 - 3\cdot 2 = 32 - 6 = 26$$

$$T_2[2] = 2\cdot 2^2 - 1 = 7$$

LET $n-1 = 3$ OR $n = 4$



CONT. FROM p. 18 3/8/62

FROM COHNS TABLES: -

$$a_1 : a_2 : a_3 : a_4 = 1 : 2\tfrac{1}{4} : 2\tfrac{1}{4} : 1$$

$$a_1 + a_2 + a_3 + a_4 = 6.5$$

n=1 $\ln \frac{Z_2}{Z_1} =$ ~~[illegible]~~ $= \frac{(1)(1.61)}{6.5} = .248$, $\frac{Z_2}{Z_1} = 1.282$

n=2 $\ln \frac{Z_3}{Z_2} = \frac{(2.25)(1.61)}{6.5} = .558$, $\frac{Z_3}{Z_2} = 1.745$

n=3 $\ln \frac{Z_4}{Z_3} = \ln \frac{Z_3}{Z_2} = .558$, $\frac{Z_4}{Z_3} = 1.745$

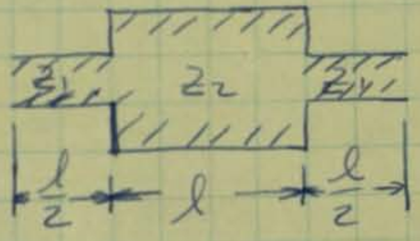
n=4 $\ln \frac{Z_5}{Z_4} = \ln \frac{Z_2}{Z_1} = .248$, $\frac{Z_5}{Z_4} = 1.282$

$b = \frac{1}{4}$

$Z_1 = 10\Omega$	$\sqrt{\varepsilon_r} Z_1 = 16\Omega.$	$w_1/b =$	
$Z_2 = 12.82\Omega$	$\sqrt{\varepsilon_r} Z_2 = 20.5\Omega.$	$w_2/b = 4.0$	$w_2 = 1.0$
$Z_3 = 22.40\Omega$	$\sqrt{\varepsilon_r} Z_3 = 35.8\Omega$	$w_3/b = 2.1$	$w_3 = .525$
$Z_4 = 39.10$	$\sqrt{\varepsilon_r} Z_4 = 62.5\Omega.$	$w_4/b = 1.05$	$w_4 = .262$
$Z_5 = 50.20$ ck.	$\sqrt{\varepsilon_r} Z_5 = 80.0\Omega.$	$w_5/b = .7$	$w_5 = .178$

l SHOULD BE $\frac{\lambda}{4}$ @ 3000 mc , $l = \frac{3 \times 10^{10}}{(1.6)(3 \times 10^9)(2.54)(4)} = .615$

CONSIDER FOLLOWING FILTER: (TRY .60)



LET $\rho = \frac{1}{3} = \frac{Y_1}{Y_2} = \frac{Z_2}{Z_1}$

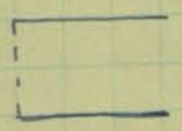
$$\frac{Y_I}{Y_1} = \pm \sqrt{\frac{\frac{4}{3} \cos\phi + \frac{2}{3}}{\frac{4}{3} \cos\phi - \frac{2}{3}}} = \pm \sqrt{\frac{2\cos\phi + 1}{2\cos\phi - 1}}$$

∴ THIS VALUE OF $\frac{Y_I}{Y_1}$ WOULD BE RECIPROCAL TO THAT TABULATED ON p. 17. ~~WILL~~ SEE FOLLOWING PAGE.

CONT. FROM p. 19

3/12/62

ϕ	Ⓐ $\sqrt{\frac{2\cos\phi-1}{2\cos\phi+1}}$	Ⓑ $\sqrt{\frac{2\cos\phi+1}{2\cos\phi-1}}$	ROTATE Ⓑ $l/2$ @ Y_1
0		1.73	1.73
50	.352	2.84	~~2.15~~ 1.25 − j 1.2
60	0	∞	− j 1.75
70	j .432	− j 2.31	− j .62
80	j .667	− j 1.50	− j .29
1.5 kmc 90	j 1.00	− j 1.00	0
100	j 1.50	− j .67	j .30
110	j 2.31	− j .43	j .62
120	∞	0	j 1.75
125	3.91	.26	.97 + j 1.43
130	2.84	.35	1.25 + j 1.20
140	2.18	.46	1.52 + j .83
150	1.93	.52	1.62 + j .56
160	1.81	.55	1.68 + j .38
170	1.75	.57	1.72 + j .2
3 kmc 180	1.73	.58	1.73
~~170~~			
~~180~~			

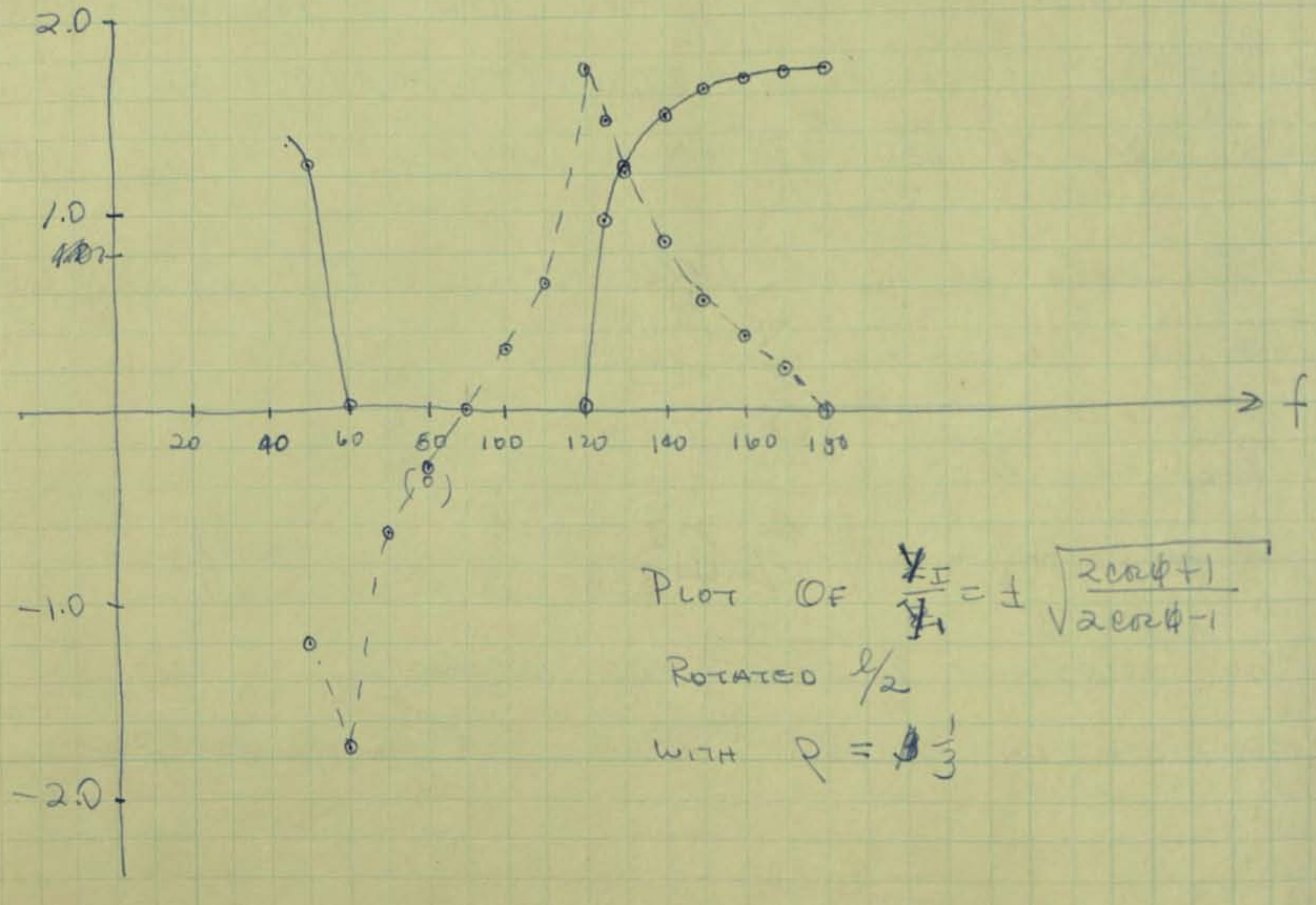


@ 3 kmc $\frac{Y_I}{Y_1} = 1.73$, $Y_I = 1.73\, Y_1$

$Z_I = \frac{Z_1}{1.73}$

SINCE $Z_1 = 112\,\Omega$, $Z_I = 69.5\,\Omega$

OR $Z_I = \frac{Z_1}{.58} = 193\,\Omega$



PLOT OF $\frac{Y_I}{Y_1} = \pm\sqrt{\frac{2\cos\phi+1}{2\cos\phi-1}}$

ROTATED $l/2$

WITH $\rho = \frac{1}{3}$

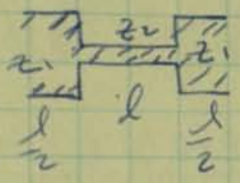
CONT. FROM p. 20 4/5/62

FROM p. 16 AT BOTTOM OF PAGE

$$\left(\frac{Y_I}{Y_1}\right)^{-1} = \frac{Y_1}{Y_I} = \frac{Z_I}{Z_1} = \pm\sqrt{\frac{2\cos\phi + 1}{2\cos\phi - 1}}$$

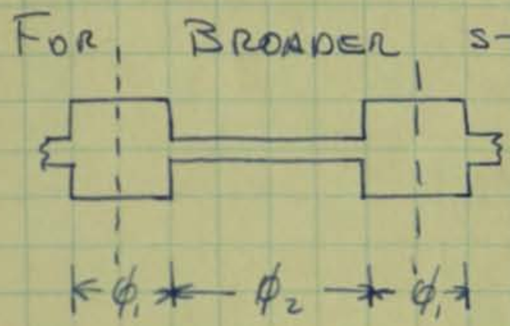
$\therefore \frac{Z_I}{Z_1}$ IS SAME PLOT $\frac{Y_I}{Y_1}$ ON p. 20 OPPOSITE.

I.E. FOR



$\{ \rho = 3$

FOR BROADER STOP BANDS CONSIDER:



LET $\phi_2 = 2\phi_1$

FROM GEPPERT'S REPORT

$$C = \frac{j}{Z_1}\sin\phi_1\cos\phi_2 + \frac{j}{2Z_1^2Z_2}\left[Z_1^2 - Z_2^2 + (Z_1^2+Z_2^2)\cos\phi_1\right]\sin\phi_2$$

$$B = jZ_1\sin\phi_1\cos\phi_2 + \frac{j}{2Z_2}\left[Z_2^2 - Z_1^2 + (Z_2^2+Z_1^2)\cos\phi_1\right]\sin\phi_2$$

ALSO $Z_1^2 - Z_2^2 + (Z_1^2+Z_2^2)\cos\phi_1 = \frac{1}{Y_1^2} - \frac{1}{Y_2^2} + \left(\frac{1}{Y_1^2}+\frac{1}{Y_2^2}\right)\cos\phi_1$

$$= \frac{Y_2^2 - Y_1^2 + (Y_2^2+Y_1^2)\cos\phi_1}{Y_1^2Y_2^2}$$

$$\therefore C = jY_1\sin\phi_1\cos\phi_2 + \frac{j}{2Y_2}\left[Y_2^2 - Y_1^2 + (Y_2^2+Y_1^2)\cos\phi_1\right]\sin\phi_2$$

$$B = \frac{j}{Y_1}\sin\phi_1\cos\phi_2 + \frac{j}{2Y_2Y_1^2}\left[Y_1^2 - Y_2^2 + (Y_1^2+Y_2^2)\cos\phi_1\right]\sin\phi_2$$

$$\frac{C}{B} = Y_1^2\,\frac{\sin\phi_1\cos\phi_2 + \frac{1}{2}\left[\frac{Y_2}{Y_1} - \frac{Y_1}{Y_2} + \left(\frac{Y_2}{Y_1}+\frac{Y_1}{Y_2}\right)\cos\phi_1\right]\sin\phi_2}{\sin\phi_1\cos\phi_2 + \frac{1}{2}\left[\frac{Y_1}{Y_2} - \frac{Y_2}{Y_1} + \left(\frac{Y_1}{Y_2}+\frac{Y_2}{Y_1}\right)\cos\phi_1\right]\sin\phi_2}$$

IF AGAIN $\rho = \frac{Y_1}{Y_2}$ & $\sin\phi_2 = \sin 2\phi_1 = 2\sin\phi_1\cos\phi_1$

CONT. FROM p. 21 4/5/62

$$\frac{C}{B} = Y_1^2 \frac{\cos\phi_2 + [\frac{1}{\rho} - \rho + (\frac{1}{\rho} + \rho)\cancel{2}\cos\phi_1]\cos\phi_1}{\cos\phi_2 + [\rho - \frac{1}{\rho} + (\rho + \frac{1}{\rho})\cancel{2}\cos\phi_1]\cos\phi_1}$$

$$\cos\phi_2 = \cos 2\phi_1 = 2\cos^2\phi_1 - 1$$

$$\therefore \frac{C}{B} = Y_1^2 \frac{2\cos^2\phi_1 - 1 + [\frac{1}{\rho} - \rho + (\frac{1}{\rho} + \rho)\cos\phi_1]\cos\phi_1}{2\cos^2\phi_1 - 1 + [\rho - \frac{1}{\rho} + (\frac{1}{\rho} + \rho)\cos\phi_1]\cos\phi_1}$$

$$\frac{C}{B} = Y_1^2 \frac{(2 + \rho + \frac{1}{\rho})\cos^2\phi_1 + (\frac{1}{\rho} - \rho)\cos\phi_1 - 1}{(2 + \rho + \frac{1}{\rho})\cos^2\phi_1 + (\rho - \frac{1}{\rho})\cos\phi_1 - 1}$$

$$\therefore \frac{Y_I}{Y_1} = \pm\sqrt{\frac{(2+\rho+\frac{1}{\rho})\cos^2\phi_1 + (\frac{1}{\rho} - \rho)\cos\phi_1 - 1}{(2+\rho+\frac{1}{\rho})\cos^2\phi_1 + (\rho - \frac{1}{\rho})\cos\phi_1 - 1}}$$

if $\phi_1 = 0$

$$\frac{Y_I}{Y_1} = \pm\sqrt{\frac{2 + \cancel{\rho} + \frac{1}{\rho} + \frac{1}{\rho} - \cancel{\rho} - 1}{2 + \rho + \cancel{\frac{1}{\rho}} + \rho - \cancel{\frac{1}{\rho}} - 1}} = \sqrt{\frac{1 + \frac{2}{\rho}}{1 + 2\rho}} = \sqrt{\frac{\rho + 2}{\rho(1+2\rho)}}$$

if $\phi_1 = \pi$

$$\frac{Y_I}{Y_1} = \pm\sqrt{\frac{2 + \rho + \cancel{\frac{1}{\rho}} - \cancel{\frac{1}{\rho}} + \rho - 1}{2 + \cancel{\rho} + \frac{1}{\rho} - \cancel{\rho} + \frac{1}{\rho} - 1}} = \sqrt{\frac{1 + 2\rho}{1 + \frac{2}{\rho}}}$$

$$\& \quad \frac{Z_I}{Z_1} = \pm\sqrt{\frac{(2+\rho+\frac{1}{\rho})\cos^2\phi_1 + (\rho - \frac{1}{\rho})\cos\phi_1 - 1}{(2+\rho+\frac{1}{\rho})\cos^2\phi_1 + (\frac{1}{\rho} - \rho)\cos\phi_1 - 1}}$$

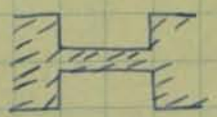
TRY FOR 3 TO 1 STOP BAND

$\phi_0 \sim 4$ Kc. $\phi_0 = 45°$

$$\frac{4}{45°} = \frac{2}{22.5} \quad \therefore \phi_{c_1} = 22.5°$$

CONT. FROM p. 16 REF. p. 16

$$\frac{Z_I}{Z_1} = \pm\sqrt{\frac{(1+\rho)\cos\phi \mp (1-\rho)}{(1+\rho)\cos\phi + (1-\rho)}}$$



ALSO FROM GEPPERT $A = \cos^2\phi - \frac{1}{2}\left(\frac{1}{\rho}+\rho\right)\sin^2\phi$

LET BAND CENTER ~ f = 5 kmc. ~ $\phi_0 = \frac{\pi}{2}$

AND f_1 = 2 kmc – CUTOFF FREQUENCY FOR LOW PASS
I.E. STOPBAND FROM 2kmc TO 8kmc.

$$\frac{\phi_c}{\phi_0} = \frac{2}{5}, \quad \phi_c = \frac{2}{\cancel{5}}\,\overset{18}{\cancel{90}}{}^\circ = 36^\circ$$

$$\{ \; -1 = \cos^2 36^\circ - \frac{1}{2}\left(\frac{1}{\rho}+\rho\right)\sin^2 36^\circ$$

$\sin 36^\circ = .588$ $\cos 36^\circ = .809$

$\sin^2 36^\circ = .346$ $\cos^2 36^\circ = .655$

$$\frac{91.5}{\underline{4}}\quad 87.5$$

$$\frac{1}{\rho} + \rho = \frac{(1.655)(2)}{.346} = 9.56$$

$$\rho^2 - 9.56\rho + 1 = 0, \quad \rho = \frac{9.56 \pm \sqrt{91.5 - 4}}{2} = \frac{9.56 \pm 9.35}{2}$$

$\therefore \rho = 9.46$ or $\rho = .11$, SELECT $\frac{Z_2}{Z_1} = 9.46$

9.56
9.35
2 | 18.91
9.455

$$\therefore \frac{Z_I}{Z_1} = \pm\sqrt{\frac{10.46\cos\phi + 8.46}{10.46\cos\phi - 8.46}}$$

$$= \pm\sqrt{\frac{1.235\cos\phi + 1}{1.235\cos\phi - 1}}$$

2 | .21
.105

TO MATCH FILTER TO 50Ω.

$Z_1 Z_2 = 2500$ AND SINCE $\frac{Z_2}{Z_1} = 9.46$

$Z_1^2\, 9.46 = 2500$

$$Z_1 = \frac{50}{\sqrt{9.46}} = \frac{50}{3.08}, \quad \boxed{\begin{array}{l} Z_1 = 16.2\,\Omega \\ Z_2 = 155\,\Omega. \end{array}}$$

CONTINUED FROM p. 23. 4/6/62

TO PLOT $\frac{Z_I}{Z_1}$ ROTATED $l/2$

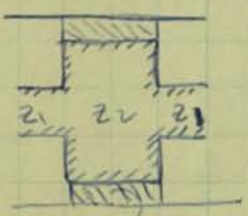
$$\frac{Z_I}{Z_1} = \sqrt{\frac{1.235 \cos\phi + 1}{1.235 \cos\phi - 1}}$$

SLOPES MUST BE (−) DUE TO FOSTERS REACTANCE THM.

kmc f	ϕ	$\cos\phi$	A $1.235\cos\phi$	A+1	A−1	$\frac{A+1}{A-1}$	$\frac{Z_I}{Z_1}$	B $\frac{Z_I}{Z_1}$ ROTATED $\frac{l}{2}$
	0	1					3.12	
	10	.985	1.215	2.215	.215	10.30	3.21	3.0 + j .75
	20	.940	1.160	2.160	.160	13.50	3.68	2.7 + j 1.55
	30	.866	1.070	2.070	.070	29.60	5.44	1.65 + j 2.90
2.0	36	.809	1.000	2.000	0	∞	∞	+ j 3.10
	40	.766	.916	1.916	−.084	− 22.80	−j 4.78	+ j 7.00
	50	.642	.783	1.783	−.217	− 8.22	−j 2.87	+ j 9.50
	60	.500	.617	1.617	−.383	− 4.22	−j 2.06	+ j 14.00
	70	.342	.412	1.412	−.588	− 2.40	−j 1.55	+ j 30.00
	80	.174	.215	1.215	−.785	− 1.55	−j 1.25	+ j 50.00
5.0	90	0	0	1.000	−1.000	− 1.000	−j 1.00	∞
	100	−.174	−.215	.785	−1.215	− .65	−j .81	− j 60.00
	110	− .342	−.412	.588	−1.412	− .42	−j .65	− j 30.00
	120	− .500	−.617	.383	−1.617	− .24	−j .49	− j 14.00
	130	− .642	−.783	.217	−1.783	− .12	−j .35	− j 9.50
	140	− .766	−.916	.084	−1.916	− .04	−j .20	− j 7.00
8.0	144	− .809	−1.000	0	−2.000	0	0	− j 3.10
	150	− .866	−1.070	− .070	−2.070	.030	.17	1.85 − j 2.75
	160	− .940	−1.160	− .160	−2.160	.075	.27	2.70 − j 1.50
	170	− .985	−1.215	− .215	−2.215	.097	.31	2.95 − j .70
10.0	180	− 1.000	−1.235	− .235	−2.235	1.05	1.03	

CONSIDER FOLLOWING DESIGN: (FROM C ABOVE)

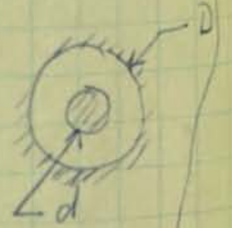
LET $\frac{Z_I}{Z_1} = .30$, IF $Z_I = 50\,\Omega$ & $\rho = .11$



$$Z_1 = \frac{50}{.30} = 167\,\Omega$$

$$Z_2 = (.11)(167) \overset{\wedge}{=} 18.5\,\Omega$$

TRY TEFLON SUPPORTS IN COAX LINE $Z_0 = \frac{138}{\sqrt{\epsilon_r}} \log \frac{D_1}{d_1}$

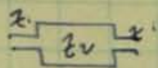


FOR Z_{21} $\sqrt{\epsilon} = \sqrt{2.1} = 1.45$ LET $D_1 = .375$

$$Z_{21} = \frac{138}{1.45} \log \frac{D_1}{d_1} = 18.5 \qquad \log \frac{.375}{d_1} = .194$$

CONT. FROM p. 24

$\frac{Z_1}{Z_2} = .105$



$B\frac{Z_1}{Z_2}$	$B\frac{Z_1}{Z_2}$ ROTATED $l/2$	C INVERT $\frac{Z_I}{Z_1}$ FOR $\rho = \frac{1}{9.46}$		D ROTATE C $l/2$ to LOAD.
		.32		.32
.314+j.078	.31-j.001	.312		.315-j.08
.282+j.016	.28-j.001	.272		.280-j.16
0.17+j.030	.16+j.035	.184		.195-j.26
j.033	+j.000	0		-j.32
j0.73	+j.300	j .209	34.9	-j.145
j .99	+j.360	j .348	53.0	-j.10
j1.46	+j.480	j .486	81.0	-j.075
j3.14	+j ~~.770~~ .920	j .645	108.0	-j.035
j5.23	+j.970	j .800	134	-j.020
∞	j1.00	j 1.000	167	0
-j5.23	j 1.24	j 1.230	205	j.020
-j3.14		j 1.54	257	j.035
-j1.46		j 2.04	340	j.070
-j .99		j 2.86	477	+j.10
-j .73		j 5.00	835	+j.16
-j .32	∞	∞	∞	+j.33
0.19+j .29	3.45-j.6	5.88		.18+~~j.18~~ j.26
280 +j .16	3.65	3.70		.27+~~j.08~~ j.16
310 -j.073	3.20	3.22		.31+j.08
		.97		1.03

$\frac{.375}{d_1} = 1.56$

$\boxed{\therefore d_1 = .240}$ = .276 IN AIR.

FOR Z_2 WILL USE AIR AS DIELECTRIC.

$167 = 138 \log \frac{D_1}{d_2}$

$\log \frac{D_1}{d_2} = 1.21$

$\boxed{\therefore d_2 = .023}$

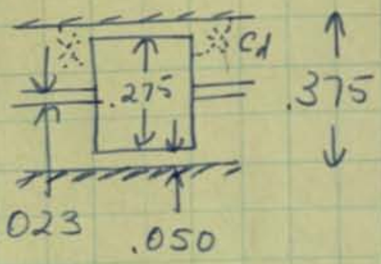
SEE NEXT PAGE.

$\frac{D_1}{d_2} =$ ~~VAAA~~ 16.2

$d_2 = \frac{.375}{\cancel{1.084}\ 16.2} = .0232$

CONT. FROM p.25. 4/17/62

CONSIDER FILTER SECTION IN AIR DIELECTRIC.



TO CALCULATE Cd FROM p. 61
IN MICROWAVE HANDBOOK

$\alpha = \frac{b-c}{b-a} = \frac{.050}{.176}$

$\gamma = \frac{b}{a} = .284$

$b = \frac{.375}{2}$

$a = \frac{.023}{2}$

$c = \frac{.275}{2}$

$$\begin{array}{r} .375 \\ .023 \\ \hline 2 \,)\, .352 \\ b-a = .176 \end{array}$$

FROM GRAPH $C_d' = .058$ pf./cm.
$= .147$ pf/in.

$C_d = \pi D C_d'$, LET $D = .325$

$C_d = (3.14)(.325)(.147)$

$C_d = .15$ pf.

TO CALCULATE THE LENGTH IN AIR OF LOW IMPEDANCE LINE
TO BE REMOVE TO COMPENSATE FOR THIS.

$\cancel{C_d = \pi D l}$

$\cancel{l = \frac{C_d}{\pi D} = .15}$

AIR.

$C_d = \frac{.225\ \epsilon_r\ A}{t}$ pf., $A = \frac{C_d t}{(.225)\epsilon_r} = \frac{(.15)(.050)}{(.225)(\cancel{\epsilon_r})(1.0)}$

$A = .033$ in^2

THEN $\pi D l = .033$, $l = \frac{.033}{(3.14)(.325)} \overset{\wedge}{=} .033''$ IN AIR.

IN TEFLON

$l = \frac{.033}{\sqrt{\epsilon_r}} = \frac{.033}{1.45} \overset{\wedge}{=} .023$

∴ .023" SHOULD BE REMOVED FROM THE LENGTH OF THE LOW IMPEDANCE LINES IN THE FILTER.

Con

C

To Cal
In Micr

α =

γ =

From Gr

C

C

C

To
To R

C

A

Then

In

ϕ	A $\cot\phi \tan\phi/2$	B $\cot\phi$ ~~tan~~ cot $\phi/2$	3.76A	3.76B	1+A	1−B
~~40~~	~~.43~~	~~3.27~~	~~1.62~~			
50	.40	1.80	1.50	6.80	1.40	−.80
60	.33	1.00	1.24	3.76	1.33	0
70	.25	.52	.94	1.95	1.25	.48
80	.15	.21	.56	.79	1.15	.79
90	0	0	0	0	1.00	1.00
100	−.21	−.15	−.79	−.56	.79	1.15
110	−.52	−.25	−1.95	−.94	.48	1.25
120	−1.00	−.33	−3.76	−1.24	0	1.33
130	−1.80	−.40	−6.80	−1.50	−.80	1.40

	$\frac{1+A}{1-B}$	$\sqrt{}$	to load $l/2$	$i/Z_1 = 50$ Z_I
50	−1.75	j 1.32	j.52	j26.0
60	∞	∞	j1.75	j 86.5
70	2.6	1.61	1.05+j.5	52.5 + j25
80	1.46	1.21	1.01+j.2	50.5 + j10
90	1.00	1.00	1.00	50
100	.69	.84	~~.98 − j.16~~ 1.01 − j.2	50.5 − j10
110	.38	.62	1.05 − j.5	52.5 − j25
120	0	0	−j 1.75	−j 86.5
130	−.57	j.76		

50

900

900

X3

650

250

250

50

∴ .023 SHOULD BE REMOVED FROM THE LENGTH OF THE

LOW IMPEDANCE LINES IN THE FILTER.

CONT. FROM p. 26 4/17/62

CENTER THE STOPBAND AT. 6 Kmc

THEN $l = \frac{\lambda}{4}$ @ 6 Kmc.

Z_2: $l_2 = \frac{1}{4} \frac{3 \times 10^{10}}{(1.45)(6 \times 10^9)(2.54)} = .340$

CORRECTING FOR Cd $l_2 = .340 - (.023)2$

~~Try $l_2 = .317 \pm .003$~~

$$\boxed{l_2 = .294 \pm .003}$$

$$\boxed{l_1 = .493 \pm .003}$$

.340
.023
~~.307~~
~~.317~~
.340
.046
.294

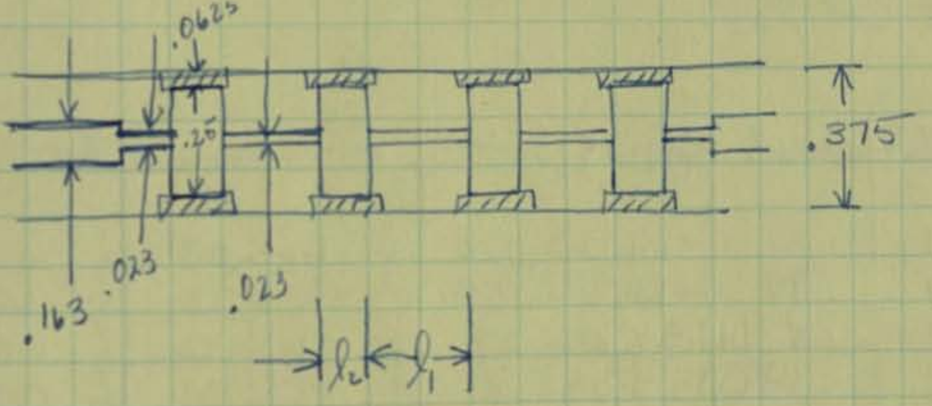
$\frac{90°}{36°} = \frac{6}{f_{c_1}}$, $f_{c_1} = 2.4$ Kmc.

∴ LOW PASS CUTOFF WILL BE

$f_{c_1} = 2.4$ Kmc.

& $f_{c_2} = 4 f_{c_1} = 9.6$ Kmc.

FILTER WILL LOOK LIKE:



FOR 50 Ω LINE

$\frac{D}{d} = 2.3$

$d = \frac{D}{2.3} = \frac{.375}{2.3}$

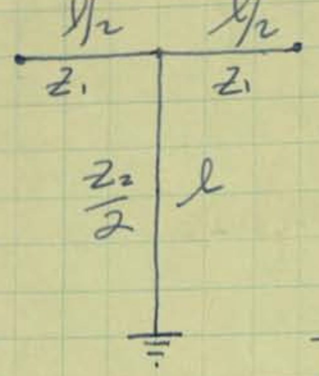
$d = .163$

.375
.125
.250

BAND PASS FILTER FOR OUTPUT DOUBLER OR TRIPLER

4/18/62

CONSIDER FOLLOWING FILTER: $\rho = \frac{Z_1}{Z_2}$



$$B = jZ_1\left[\sin\phi + \rho\cos\phi\tan\tfrac{\phi}{2}\right]$$

$$C = j\frac{\sin\phi}{Z_1} - j\frac{\cos\phi}{Z_2\tan\frac{\phi}{2}}$$

$$\frac{B}{C} = Z_1^2\left[\frac{\sin\phi + \rho\cos\phi\tan\phi/2}{\sin\phi - \rho\cos\phi\cot\phi/2}\right],\ \text{WHERE } \rho = \frac{Z_1}{Z_2}$$

$$\frac{B}{C} = Z_1^2\left[\frac{1+\rho\cot\phi\tan\phi/2}{1-\rho\cot\phi\cot\phi/2}\right]$$

$$\frac{Z_I}{Z_1} = \pm\sqrt{\frac{1+\rho\cot\phi\tan\phi/2}{1-\rho\cot\phi\cot\phi/2}}$$

LET $\rho = 1$

$$\frac{Z_I}{Z_1} = \pm\sqrt{\frac{1+\cot\phi\tan\phi/2}{1-\cot\phi\cot\phi/2}}$$

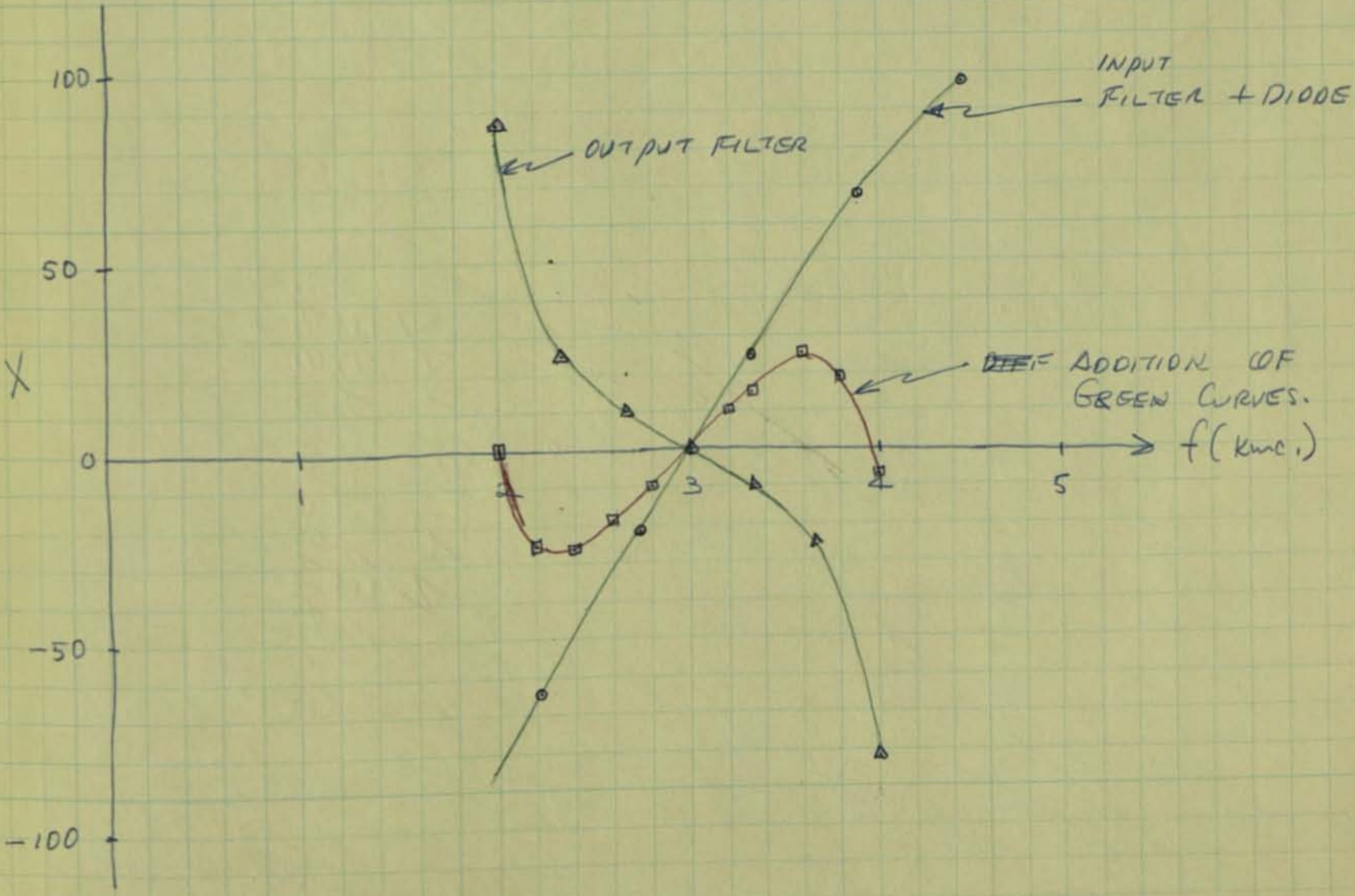
ϕ	$\cot\phi$	$\cot\frac{\phi}{2}$	$\cot\phi\cot\frac{\phi}{2}$	$\tan\frac{\phi}{2}$	$\cot\phi\tan\frac{\phi}{2}$	$1+\cot\phi\tan\frac{\phi}{2}$	$1-\cot\phi\cot\frac{\phi}{2}$	$\frac{1+\cdots}{1-\cdots}$	A $\frac{Z_I}{Z_1}$	B ROTATE A ℓ/2	B×50Ω	f
0												
10	5.67	11.43	65.0	.09	.51	1.51	−64.0	−.024	j.16	j.07	j 35	
20	2.75	5.67	15.6	.18	.49	1.49	−14.6	−.102	j.32	j.13	j 6.5	
30	1.73	3.73	6.45	.27	.47	1.47	−5.45	−.27	j.52	j.22	j 11.0	
40	1.19	2.75	3.27	.36	.43	1.43	−2.27	−.63	j.80	j.34	j 17.0	
50	.84	2.14	1.80	.47	.40	1.40	−.80	−1.75	j1.32	j.53	j 26.5	
60	.58	1.73	1.00	.58	.33	1.33	0	∞	∞	j1.73	j 86.5	2.0
70	.36	1.43	.52	.70	.25	1.25	.48	2.60	1.61	1.05+j.5	52.5+j25	2.33
80	.18	1.19	.21	.84	.15	1.15	.79	1.46	1.21	1.02+j.2	51.0+j10	2.67
90	0	1.00	0	1.00	0	1.00	1.00	1.00	1.00	1.00	50.0	3.0
100	−.18	.84	−.15	1.19	−.21	.79	1.15	.69	.83	1.02−j.2	51.0−j10	3.33
110	−.36	.70	−.25	1.43	−.52	.48	1.25	.38	.62	1.05−j.5	52.5−j25	3.67
120	−.58	.58	−.33	1.73	−1.00	0	1.33	0	0	−j1.73	−j 86.5	4.0
130	−.84	.47	−.40	2.15	−1.80	−.80	1.40	−.57	j.75	−j.53	−j 26.5	

CONTINUED FROM p. 28   4/19/62

COMPARISON OF OUTPUT. FILTER & DIODE REACTANCES VS. FREQUENCY. (AT OUTPUT DOUBLED FREQUENCY)

f (kmc)	INPUT FILTER	DIODE	FILTER + DIODE
2.22	34.9	− 100	− 65.0
2.78	53.0	− 75	− 22.0
3.33	81.0	− 55	26.0
3.90	108.0	− 40	68.0
4.45	134.0	− 30	94.0
5.00	167.0	− 22	145.0
5.55	205.0	− 17	188.0
6.10	257.0		
6.70	340.0		
7.20	477.		
7.80	835.		

TAKEN FROM EXPERIMENTAL CURVES.



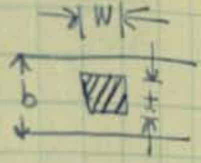
CONT. FROM P.29. 4/19/62

CUTOFF OF L. P. FILTER IS ACTUALLY AT 2.4 KMC. THEREFORE WILL TRY TO HAVE H. P. FILTER BEGIN AT SAY 2.3 KMC AND END AT 4.6 KMC.

$$\therefore\ f_0 = \begin{array}{r} 2.3 \\ 4.6 \\ 2\overline{)6.9} \end{array} = 3.45 \simeq 3.4 \text{ KMC}$$

AND ℓ THE LENGTH OF LINE WILL BE:

$$\ell = \frac{1}{4}\,\frac{3\times10^{10}}{(3.4\times10^{9})(2.54)} = .870''$$

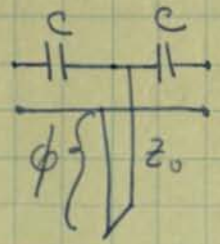


SINCE $Z_I = Z_1 = Z_2 = 50\ \Omega$. $\left\{ \begin{array}{l} b = .25 \\ \text{LET } t = .125 \end{array} \right.$ $t/b = .5$

$\frac{w}{b} = .48$

$w = .12$, $\therefore$ 1/8 X 1/8 STOCK SHOULD BE O.K.

4/20/62 ANOTHER POSSIBLE OUTPUT FILTER



$$\begin{pmatrix} A & B \\ C & D \end{pmatrix} = \begin{pmatrix} 1 & \frac{1}{j\omega C} \\ 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 \\ \frac{1}{jZ_0\tan\phi} & 1 \end{pmatrix} \begin{pmatrix} 1 & \frac{1}{j\omega C} \\ 0 & 1 \end{pmatrix}$$

$$= \begin{pmatrix} 1 - \frac{1}{\omega C Z_0 \tan\phi} & \frac{1}{j\omega C} \\ \frac{1}{jZ_0\tan\phi} & 1 \end{pmatrix} \begin{pmatrix} 1 & \frac{1}{j\omega C} \\ 0 & 1 \end{pmatrix}$$

$$= \begin{pmatrix} 1 - \frac{1}{\omega C Z_0 \tan\phi} & \frac{1}{j\omega C}\left(1 - \frac{1}{\omega C Z_0 \tan\phi}\right) + \frac{1}{j\omega C} \\ \frac{1}{jZ_0\tan\phi} & -\frac{1}{\omega C Z_0 \tan\phi} + 1 \end{pmatrix}$$

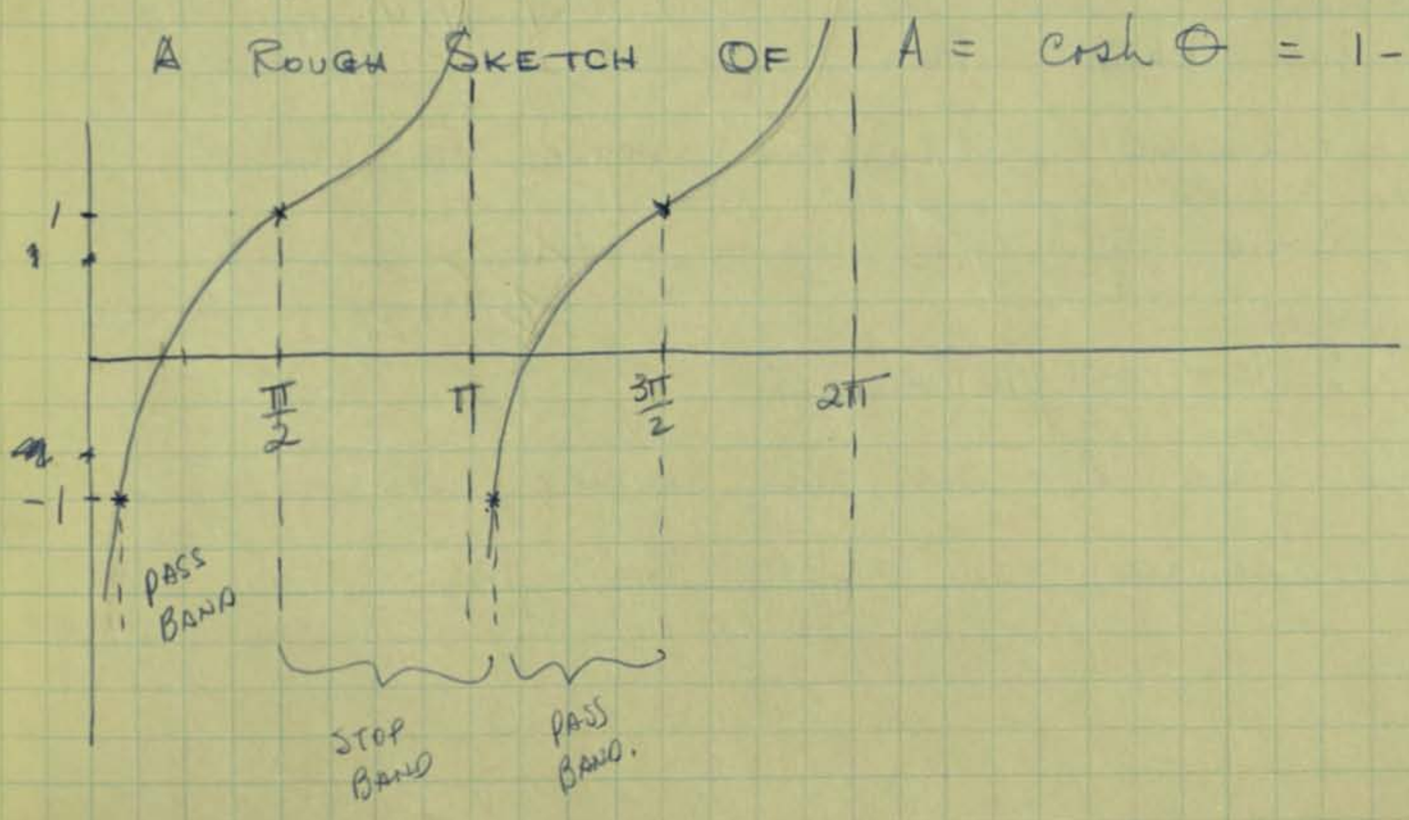
$$\therefore \quad A = D = 1 - \frac{1}{\omega C Z_0 \tan\phi} \qquad C = \frac{1}{jZ_0\tan\phi}$$

$$B = \frac{1}{j\omega C}\left(2 - \frac{1}{\omega C Z_0 \tan\phi}\right)$$

$$Z_I = \pm\sqrt{\frac{B}{C}} = \pm\sqrt{\frac{Z_0\tan\phi}{\omega C}\left(2 - \frac{1}{\omega C Z_0 \tan\phi}\right)}$$

$$= \pm\sqrt{\frac{1}{\omega C}\left(2Z_0\tan\phi - \frac{1}{\omega C}\right)} = \pm\frac{1}{\omega C}\sqrt{2\omega C Z_0 \tan\phi - 1}$$

A ROUGH SKETCH OF $A = \cosh\theta = 1 - \frac{1}{\omega C Z_0}\cot\phi$

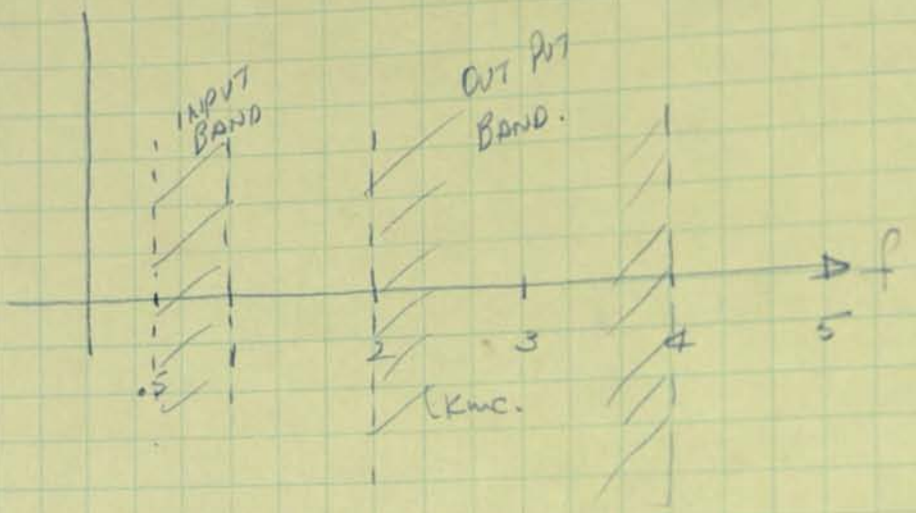


5/3/62

MORE HARMONIC GENERATION

DESIRE $\frac{1}{2}$ WATT AT 2250 mc

TRY FOR QUADRUPLING FROM 562.5 mc



WILL SCALE DESIGN Pg. 27 (FOR LOW PASS)

f_{c_1} ACTUALLY TURNED OUT TO BE 2.2 Kmc.

∴ LENGTHS SHOULD BE SCALED BY RATIO $\frac{2.2}{\cancel{.5}\ .9}$ = ~~4.4~~ 2.44

$$\therefore \boxed{\begin{aligned} l_2 &= (2.44)(.294) = .720 \\ l_1 &= (2.44)(.493) = 1.205 \end{aligned}}$$

FOR THE BAND PASS (pg. 30)

$\left\{ \begin{aligned} f_{c_1} &= 2.6\text{ Kmc.} \\ f_0 &= 3.55 \end{aligned} \right.$ ∴ LENGTHS SHOULD BE SCALED BY RATIO $\frac{3.55}{3.45} = 1.03$

$$\boxed{\therefore\ l = (1.03)(.870) = .895}$$

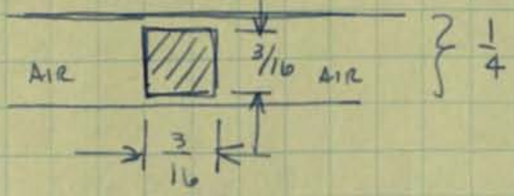
SHOULD SCALE $l_2 = .340$ THEN SUBTRACT .046" SEE p. 27

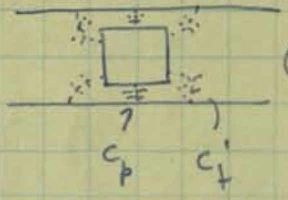
$(2.44)(.340) - .046 = .830 - .046 = \underline{.784}$

$\begin{array}{r} 83? \\ 046 \\ \hline .784 \end{array}$

5/4/62 LOWER IMPEDANCE OUTPUT FILTER FOR HARMONIC GEN. (REFERENCE p. 30)

CONSIDER :





$C = 2C_p + 4C_f'$

$$Z_0\sqrt{\epsilon_r} = \frac{\eta}{C/\epsilon} \quad , \quad \eta = 376.7$$

$\sqrt{\epsilon_r} = 1$

$\frac{w}{b} = \frac{\frac{3}{16}}{\frac{1}{4}} = .75$

$\frac{t}{b} = .75$

$C = 2C_p + 4C_f'$

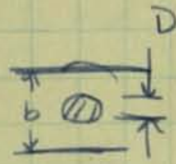
$$\frac{C_p}{\epsilon} = 2\,\frac{w/b}{1 - t/b} = 2 \cdot \frac{\frac{3}{4}}{\frac{1}{4}}$$

$$\frac{C_p}{\epsilon} = 6 \; , \; \frac{C_f'}{\epsilon} = 1.5$$

$$\frac{C}{\epsilon} = 2 \cdot 6 + 4 \cdot 1.5 = 12 + 6 = 18$$

$$Z_0 = \frac{376.7}{18} = 21\,\Omega.$$

FOR QUARTER WAVE TRANSFORMER (MATCHING TO 50Ω) $Z_m = \sqrt{50 \cdot 20}$

$Z_m = 31.6\,\Omega.$ Try  CONSTRUCTION.

$\frac{D}{b} = .76 \quad , \quad D = .76 \cdot \frac{1}{4} = \underline{\underline{.190}}$

TRY TO CENTER AT 3 KMC,

$$l = \frac{3 \times 10^{10}}{4(3 \times 10^9)\,2.54} = .984.$$

5/15/62

QUADRUPLER
FROM p. 32.

CONSIDERATION OF SELF RESONANT FREQ. OF DIODE PLUS FILTER WITH L.P. CUTOFF AT 1 KMC.

FROM p. 29. & 28 $f_{c.} = 2.4$ KMC. ∴ FREQUENCY VALUES MUST BE SCALED BY $\frac{1.0}{2.4} \cong .42$

f(KMC) P. 29	f (KMC) SCALED	INPUT FILTER Ω	DIODE Ω		FILTER + DIODE Ω
2.22	.92	34.9	~~+100~~		~~-65~~
2.78	1.16	53.0	~~-75~~		~~-22~~
3.33	1.39	81.0	~~-55~~	-180	-79
3.90	1.63	108.0	~~-40~~	-140	-32
4.45	1.90	134.0	~~-30~~	-115	19
5.00	2.08	167.0	~~+22~~	-100	67
5.55	2.31	205.0	~~+17~~	-85	120
6.10	2.54	257.0		-70	
6.70	2.80	340.0		-60	
7.20	3.00	477.0		-50	
7.80	3.25	835.0		-45	

CONSIDER OUTPUT FILTER DESIGN AGAIN:

IF USE 21Ω SHUNT STUBS AND CENTER BAND AT $f_0 = 2.4$ Kmc

$$\rho = \frac{Z_1}{Z_2} = \frac{50}{21} = 2.4 \,, \qquad 1 = (1+\rho)\,\mathrm{cn}\,\theta_c$$

$$\mathrm{Cn}\,\theta_c = \frac{1}{3.4} \cong .29$$

$$\theta_c \cong 73^\circ \qquad \frac{90}{73} = \frac{2.4}{f_c} \,, \quad \underline{f_c = 1.95\,\mathrm{Kmc}}$$

$$\ell = \frac{\lambda}{4}\Big]_{\text{at } 2.4\text{kmc}} = \frac{1}{4}\;\frac{3\times10^{10}}{2.4\times10^{9}\;2.54} = 1.23''$$

DEGENERATE PARAMETRIC AMPLIFIER USING FD-6 6/14/62

SELF RESONANT DIODE FREQ. $f_{res.} = 10$ Kmc.

$R_s = 1.0\,\Omega$ ∴ input FREQ IS 5 Kmc.

$C_{-1v.} \cong 1.2\,pf.$

ASSUME $\frac{C_o}{C(V_0)} = 1.2$ FROM KOTZEBUE'S TEXT $\left(\frac{V}{V_0} = \frac{\text{pump volt}}{\text{total static volt}} = .9 \right)$

$$\therefore C(-1) = \frac{C_{-1}}{1.2} = 1\,pf$$

HERE WE WILL ASSUME TO OPERATE AT -1 volts. BIAS

LET pumping PARAMETER $a = .25$, $1-a^2 \cong .94$

TO CALCULATE R_{bo}, THE REAL PART OF OPTIMUM DIODE IMPED. FOR A SPECIFIED DIODE Q AND AMPLIFIER GAIN.

$$Q_d = \frac{1}{2\pi f_0 R_s \underset{C(-1)}{C_o} (1-a^2)} = \frac{1}{2\pi (5\times10^9)(1.0)(1\times10^{-12})(.94)}$$

$$\boxed{Q_d = 32.2} \leftarrow$$ Q OF SERIES RESONATED DIODE AT 5 Kmc

USING CURVES OF MATTHAEI "OPTIMUM DESIGN OF WIDEBAND PARAMPS." $\frac{R_b}{a(X_{11})_0}$ IS PLOTTED AS A FUNCTION OF GAIN WITH aQ_d AS A PARAMETER.

$$\{ (X_{11})_0 = \frac{1}{2\pi f_0 C(-1)(1-a^2)} = 32.2 \text{ ALSO}$$

$$\{ aQ_d = 8.05$$

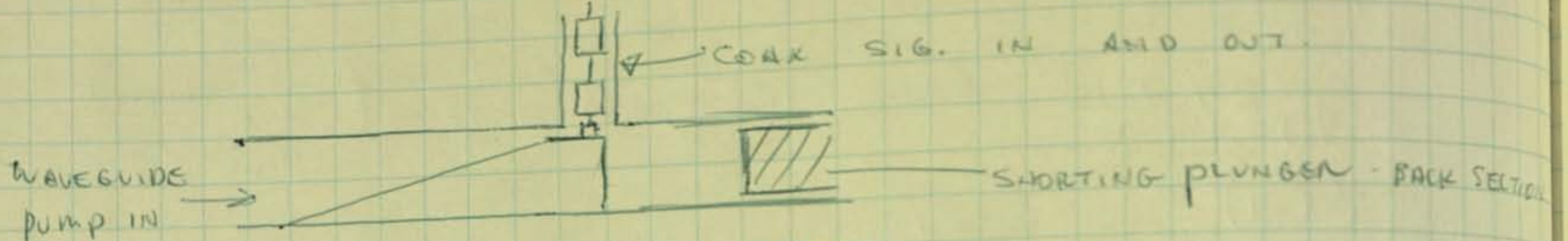
ALSO SELECTING GAIN AT 15 db, $\{ aQ_d = 8$

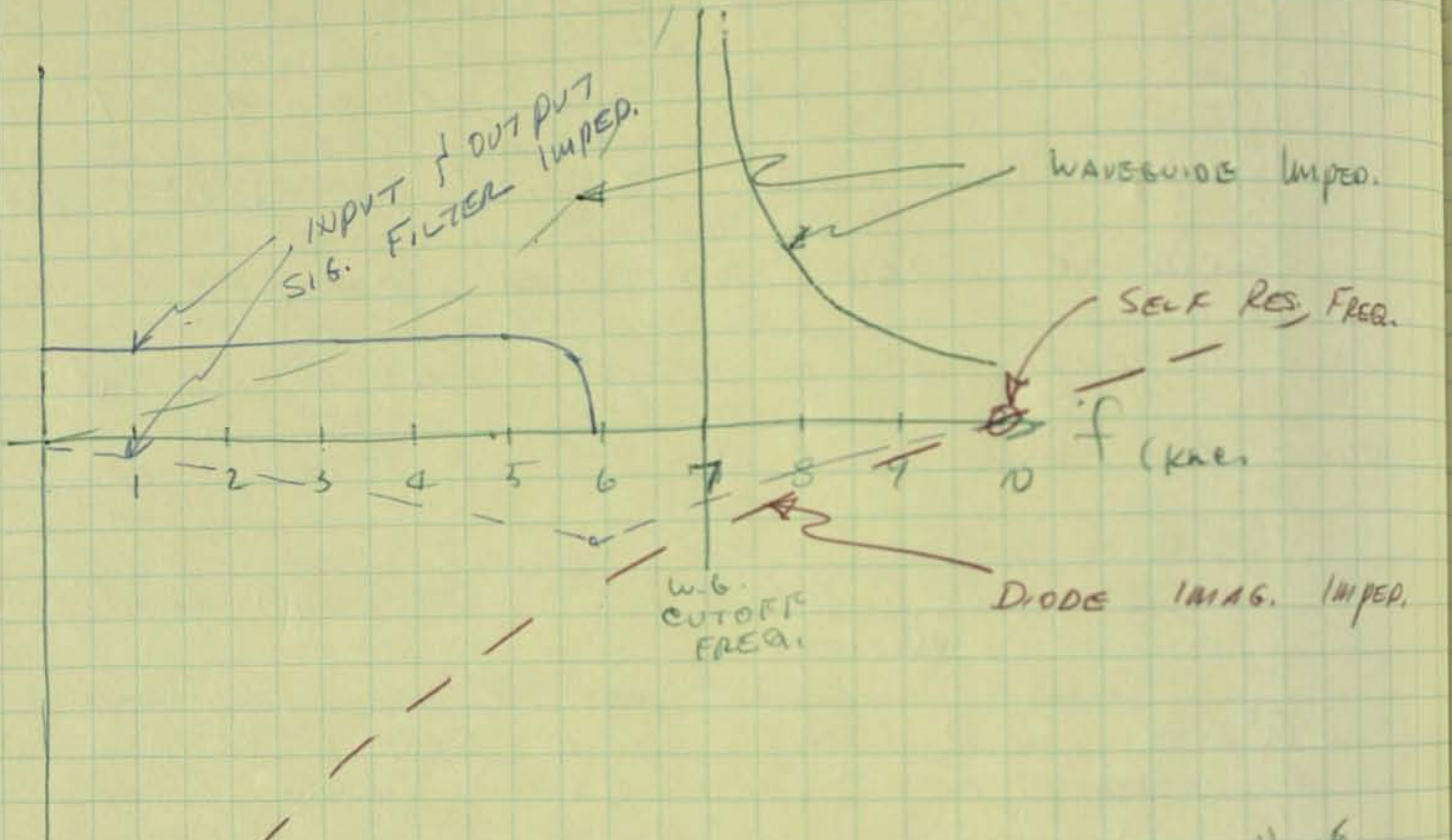
$\frac{R_{bo}}{a(X_{11})_0} \cong 1$, $\boxed{R_{bo} = \frac{1}{4}\, 32.2 \cong 8\,\Omega}$

CONT. FROM p. 35

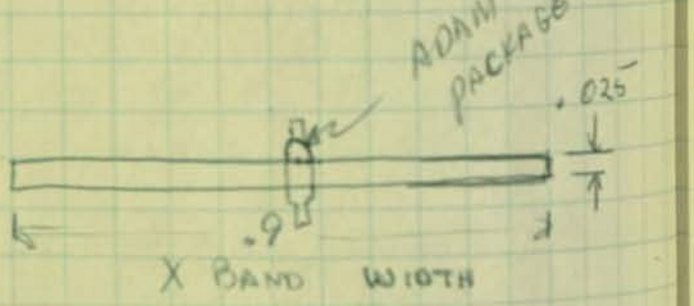
6/15/62

CONSIDER IMPEDANCE VALUES OF FOLLOWING SKETCH





WAVEGUIDE DIMENSIONS



$$Z_0 = 60\pi^2 \frac{b}{a} \frac{1}{\sqrt{1-\left(\frac{f_c}{f}\right)^2}} \quad , \quad \frac{b}{a} = \frac{.025}{.9} = .028$$

$$Z_0 = \frac{16.5}{\sqrt{1-\left(\frac{f_c}{f}\right)^2}}$$

$f_c = 6.56$ KMC

CONT. FROM p. 36 6/15/62

TABLE OF WAVEGUIDE Z_o VALUES.

f freq. (KMC)	$\frac{6.56}{f}$	$\left(\frac{6.56}{f}\right)^2$	$1-(\;)^2$	$\sqrt{1-(\;)^2}$	Z_0 (Ω)	$2Z_0$ (Ω)
4.0	1.62	2.62	-1.62	$\pm j\,1.27$	$j\,13.0$	$j\,26.0$
4.5	1.44	2.08	-1.08	$\pm j\,1.04$	$j\,15.9$	$j\,31.8$
5.0	1.30	1.69	$-.69$	$\pm j\,.83$	$j\,19.9$	$j\,39.8$
5.5	1.18	1.39	$-.39$	$\pm j\,.63$	$j\,26.2$	$j\,52.4$
6.0	1.08	1.17	$-.17$	$\pm j\,.41$	$j\,40.2$	$j\,80.4$

$2Z_0$ WAS PLOTTED BECAUSE THE COAX SIG LINE SEES 2 WAVEGUIDES IN SERIES

PLOT OF SUM OF $\text{Im}\{\text{Diode } Z\}$ AND $2Z_0$

f.	$2Z_0$	Diode	$2Z_0$ + Diode
4.0	$j\,26$	$-j\,45$	$-j\,19.0$
4.5	$j\,31.8$	$-j\,37$	$-j\,6.2$
5.0	$j\,39.8$	$-j\,31$	$+j\,8.8$
5.5	$j\,52.4$	$-j\,26$	$+j\,26.4$
6.0	$j\,80.4$	$-j\,21$	$+j\,59.4$

CONSIDER FOLLOWING FILTER DESIGN

From p. 24 (p. 23)

$$\frac{Z_I}{Z_1} = +j\sqrt{\frac{(1+\rho)\cos\phi-(1-\rho)}{(1+\rho)\cos\phi+(1-\rho)}} \qquad \rho = \frac{Z_2}{Z_1}$$

ALSO LET $f_c = 6$ KMC. AND $f_0 = 10$ KMC.

f_0 IS OPEN CIRCUIT FREQ. OF FILTER

$$\frac{\phi_c}{\phi_0} = \frac{6}{10}, \quad \phi_c = .6\,\phi_0 \;\&\; \phi_0 = \pi/2, \quad \therefore \phi_c = 54^\circ$$

$$\text{Also } -1 = \cos^2 54^\circ - \tfrac{1}{2}\left(\tfrac{1}{\rho}+\rho\right)\sin^2 54^\circ$$

$$\cos^2 54^\circ = 346, \quad \sin^2 54^\circ = .655$$

CONT. FROM
p. 37

6/15/62

$-1 = .346 - \frac{1}{2}(\quad).655$

$\frac{(1.346)^2}{.655} = \frac{1}{\rho} + \rho = 4.1, \quad \rho^2 - 4.1\rho + 1 = 0$

$\rho = \frac{4.1 \pm \sqrt{16.8 - 4}}{2} = 2.05 \pm 1.79$

$\rho = .26$ or 3.84

WITH THIS CASE $\frac{Z_2}{Z_1} = .26$

THEN

$\frac{Z_I}{Z_1} = \sqrt{\frac{1.26\cos\phi - .74}{1.26\cos\phi + .74}}$ at $\phi = 0$

$\frac{Z_I}{Z_1} = \sqrt{\frac{.52}{2.00}} = \sqrt{.26} = .51$

$Z_1 = \frac{Z_I}{.51}$, if $Z_I = 8\,\Omega.$ $\quad Z_1 \doteq 16\,\Omega$

$Z_2 \doteq 4\,\Omega$

For 16 Ω air line

$.116 = \frac{16}{138} = \log\frac{D}{d}$, LET $D = .25$

$\frac{D}{d} = 1.3$, $d = \frac{D}{1.3} = \frac{.25}{1.3} = .192$

USING TEFLON DIELECTRIC FOR SUPPORT - $Z = 4\,\Omega.$

$\frac{(4)(2.1)}{138} = \log\frac{D}{d}$

$.061 = \log\frac{D}{d}$ $\quad \frac{D}{d} = 1.15$, $d = \frac{.25}{1.15} = .218$

For length in air $l = \frac{1}{4}\frac{3\times10^{10}}{(10\times10^{9})(2.54)} = \frac{3}{(4)(2.54)} = \underline{.295}$

in Teflon $l' = \frac{.295}{1.45} = \underline{.204}$ remove .030 for fringing cap.

Con't from p. 38 6/15/62

$Z_1 = 16\,\Omega$ $\ell_1 = .295$

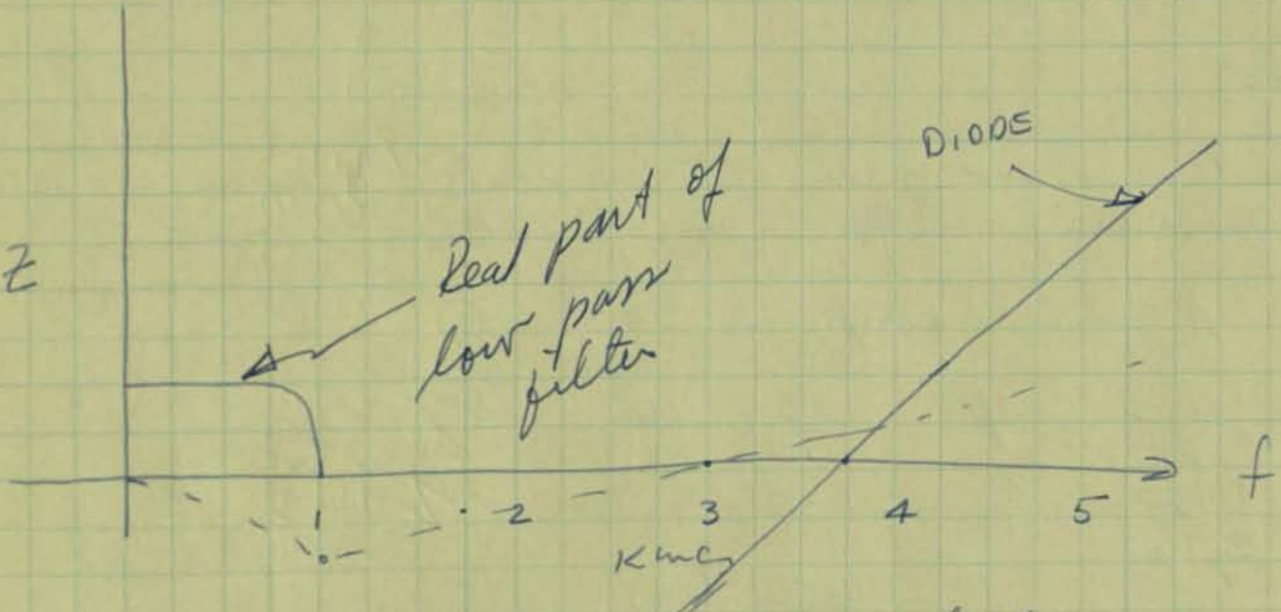
$Z_2 = 4\,\Omega$ $\ell_2 = .174.$

$$\begin{array}{r} .204 \\ \underline{030} \\ .174 \end{array}$$

More harmonic generation 6/27/62
(Quadrupling)

Results of design on p. 34 for quadrupler were at best only about 12% eff. at one freq. It is felt that the self resonant freq. is too high to work with ~~in~~ the "ADAM" package diode. ∴ a non-ADAM package diode was checked out and found to have a self resonant freq. of about 3.7 kmc. It is felt that ~~that~~ this can be more easily controlled. Also, it was found that a real input imped. of about 20Ω was necessary to get optimum efficiency.

CONSIDER THE FOLLOWING IMPED. SKETCH:-



Will try $Z_I = 20\,\Omega$ for low pass filter

From p. 24 $\frac{Z_I}{Z_1} = .3$

$Z_1 = \frac{Z_I}{.3} = \frac{20}{.3} = 66.7\,\Omega$, $\rho = \frac{Z_2}{Z_1}$

$\rho = .11$

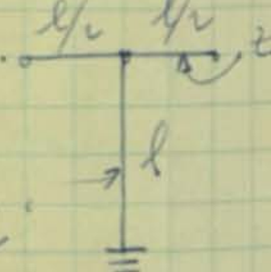
$Z_2 = (.11)(66.7) \cong 7.3\,\Omega$

Cont. from p. 39 6/27/62

Consider filter impedance plot from p. 2~~4~~ (compensated) (column labeled D)

f. Kmc.	φ	D. ZI/Z1	A ZI z1 = 66.7 Ω.	B Zd Diode	A+B	ZI0 OF OUTPUT FILTER BELOW
	0	.32				
	10	.315 − j.08				
	20	.280 − j.16				
	30	.195 − j.26				
1.65	40	~~j.33~~ −j.145	−j9.70	~~4~~		
2.06	50	~~j.145~~ −j.10	−j6.67			
2.97	60	~~j.10~~ −j.075	−j5.00	−j51.0	−j56.0	+j86.5
2.89	70	~~j.075~~ −j.035	−j2.30	−j29.0	−j31.3	52.5 + j25.0
3.29	80	−j.020	−j1.33	−j14.0	−j15.3	50.5 + j10.0
3.7	90	~~j.020~~ 0	0	0	0	50
4.11	100	+j.020	+j1.33	+j9.	+j10.3	50.5 − j10.0
4.53	110	+j.035	+j2.30	+j21.0	+j23.3	52.5 − j25.0
4.94	120	+j.075	+j5.00	+j32.0	+j37.0	− j86.0
5.35	130	+j.10	+j6.67			
	140	+j.145	+j9.70			
	150	.195 + j.26				
	160	.280 + j.16				
	170	.315				
	180	.320				

Consider band pass of 3.2 Kmc to 4.2 Kmc centered at 3.7 Kmc using filter type p. 28.



$A = (1+\rho)\cos\phi$ $\rho = \frac{Z_1}{Z_2}$

$1 = (1+\rho)\cos\phi$

$1 = (1+\rho) .21$

$1+\rho = 4.76$

$\rho = 3.76$

$\frac{3.7}{3.2} = \frac{90^\circ}{\chi}$

$\chi = 78^\circ$

$\cos 78^\circ = .21$

$\{ Z_1 = Z_I = 50\,\Omega,$

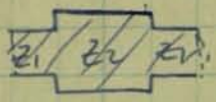
$\therefore Z_2 = \frac{Z_1}{\rho} = \frac{50}{3.76} = 13.3\,\Omega$

$$\frac{Z_I}{Z_1} = \pm\sqrt{\frac{1 + 3.76 \cot\phi \tan \theta/2}{1 - 3.76 \cot\phi \cot \theta/2}}$$

CONT. FROM p. 40

LOW PASS FILTER CONSTRUCTION :-

$Z_1 = 66.7\,\Omega$, $Z_2 = 7.3\,\Omega$.



COAX DIMENSIONS FOR Z_1 (AIR DIELECTRIC)

$$Z_1 = 138 \log \frac{D}{d}, \quad \text{let } D = .375$$

$$\log \frac{D}{d} = \frac{66.7}{138} = .483, \quad \frac{D}{d} = 3.04$$

$$d_1 = \frac{.375}{3.04} = .123 \cong \underset{\sim}{.125}$$

COAX DIMENSIONS FOR Z_2 (TEFLON DIELECTRIC)

$$Z_2 = \frac{138}{1.45} \log \frac{D}{d}$$

$$\log \frac{D}{d} = \frac{(1.45)(7.3)}{138} = .0767$$

$$\frac{D}{d_2} = 1.19, \quad d_2 = \frac{.375}{1.19} = .315, \quad 2\overline{)\,.060}$$

.375
.315
.060
.030

~~Center of stop pass band will be 3.7 Kmc~~

$$\frac{5\text{ Kmc.}}{2\text{ Kmc.}} = \frac{3.7\text{ Kmc}}{f_c}, \quad f_c = 1.48\text{ Kmc}$$

$\therefore l = \frac{\lambda}{4}$ @ 3.7 Kmc in air

$$l_1 = \frac{1}{4}\,\frac{3\times10^{10}}{(3.7\times10^{9})(\cancel{1.45})(2.54)} = \underset{\sim}{.798''}$$

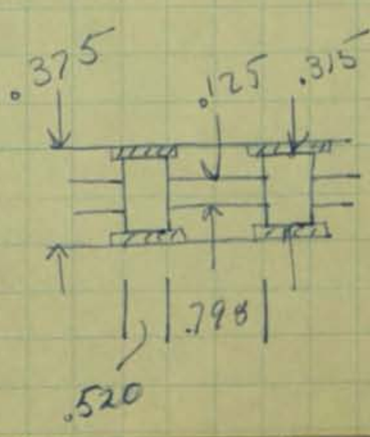
7.5
4 2.5

in teflon

$$l_2' = \frac{.798}{1.45} = \underset{\sim}{.550''}$$

Correction about .030

$$\therefore l_2 = .550 - .030 = \underset{\sim}{.520.}$$



CONT. FROM p. 41.

CONSIDER MATCHING TRANSFORMER FROM 20Ω TO 50Ω OVER FREQUENCY RANGE 3.2 KMC TO 4.2 KMC.

if $n=2$ & USING $S_{max} = 1 + \dfrac{\ln\left[\frac{Z_{n+1}}{Z_1}\right]}{T_{n-1}\left[\frac{1}{\cos\phi_1}\right]}$

$$p = \frac{f_2}{f_1} = \frac{4.2}{3.2} = 1.31$$

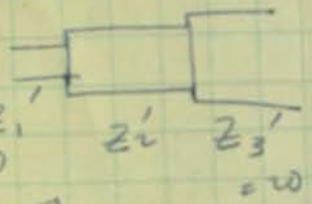
$$\phi_1 = \frac{180^\circ}{1+p} = \frac{180^\circ}{2.31} = 78^\circ, \quad \cos 78^\circ = .208$$

$$\frac{1}{\cos\phi} \simeq 5, \quad \ln\frac{Z_{n+1}}{Z_1} = \ln\frac{50}{20} = \ln 2.5 = .92$$

$$\& \; T_1(x) = x \quad \therefore \; T_1(5) = 5$$

$$S_{max} = 1 + \frac{.92}{5} = 1 + .18$$

$$S_{max} \simeq 1.18$$



$$Z_2' = \sqrt{50 \cdot 20} = 5.2\sqrt{2.5} = 10\sqrt{10}$$

$$\underline{Z_2' = 31.6\,\Omega}$$

i air $\quad Z_2' = 138 \log\dfrac{.375}{d_2'}, \quad \log\dfrac{.375}{d_2'} = \dfrac{31.6}{138} = .229$

i teflon $\log\dfrac{.375}{d_2} = ~~.338~~ .337$

$$\frac{.375}{d_2'} = 1.69, \quad d_2' = \frac{.375}{1.69} = \underline{.222}$$

[illegible] $\dfrac{.375}{d_2} = 2.14$

$$\underline{\ell_2' = .798''}$$

$d_2 = .175$

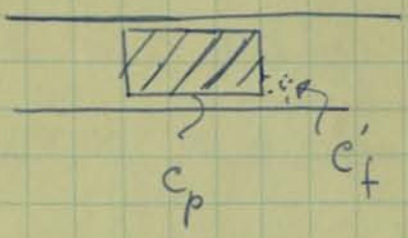
7/5/62

CALCULATING THE GEOMETRY ~~TAPED~~ OF A 13.3 Ω IMPEDANCE.

FROM p. 33

$$C = 2C_p + 4C_f'$$

$$\frac{C_p}{\epsilon} = 2\,\frac{w/b}{1 - t/b}$$



$$Z_0 = \frac{\eta}{C/\epsilon}$$

PICK $\frac{t}{b} = .9$, & $\frac{C_f'}{\epsilon} = 2.1$

$$\frac{C}{\epsilon} = \frac{\eta}{Z_0} = \frac{376.7}{13.3}$$

$$\frac{C}{\epsilon} = 28.3$$

THEN $28.3 = 2\frac{C_p}{\epsilon} + 8.4$

$$\frac{C_p}{\epsilon} \cong 10 = 2\,\frac{w/b}{1-.9}, \quad w/b = (5)(.1)$$

OR $\frac{w}{b} = .5$, $w = \frac{.50}{4} = .13$ if $b = \frac{1}{4}$

TRY $\frac{t}{b} = .8$, $\frac{C_f'}{\epsilon} = 1.65$, $4\frac{C_f'}{\epsilon} = 6.60$

$$\begin{array}{r} 28.3 \\ 6.6 \\ \hline 2\,\big)\,21.7 \\ 10.85 \end{array}$$

$$\frac{C_p}{\epsilon} = 10.85 = 2\,\frac{w/b}{1-.8}$$

$$\frac{w}{b} = \frac{10.85}{\cancel{2}}(.\cancel{2})^{.1} = 1.085$$

$w = \frac{1.085}{4} = \underset{\sim\sim}{.271}$ $t = \frac{.8}{4} = \underset{\sim\sim}{.20}$.

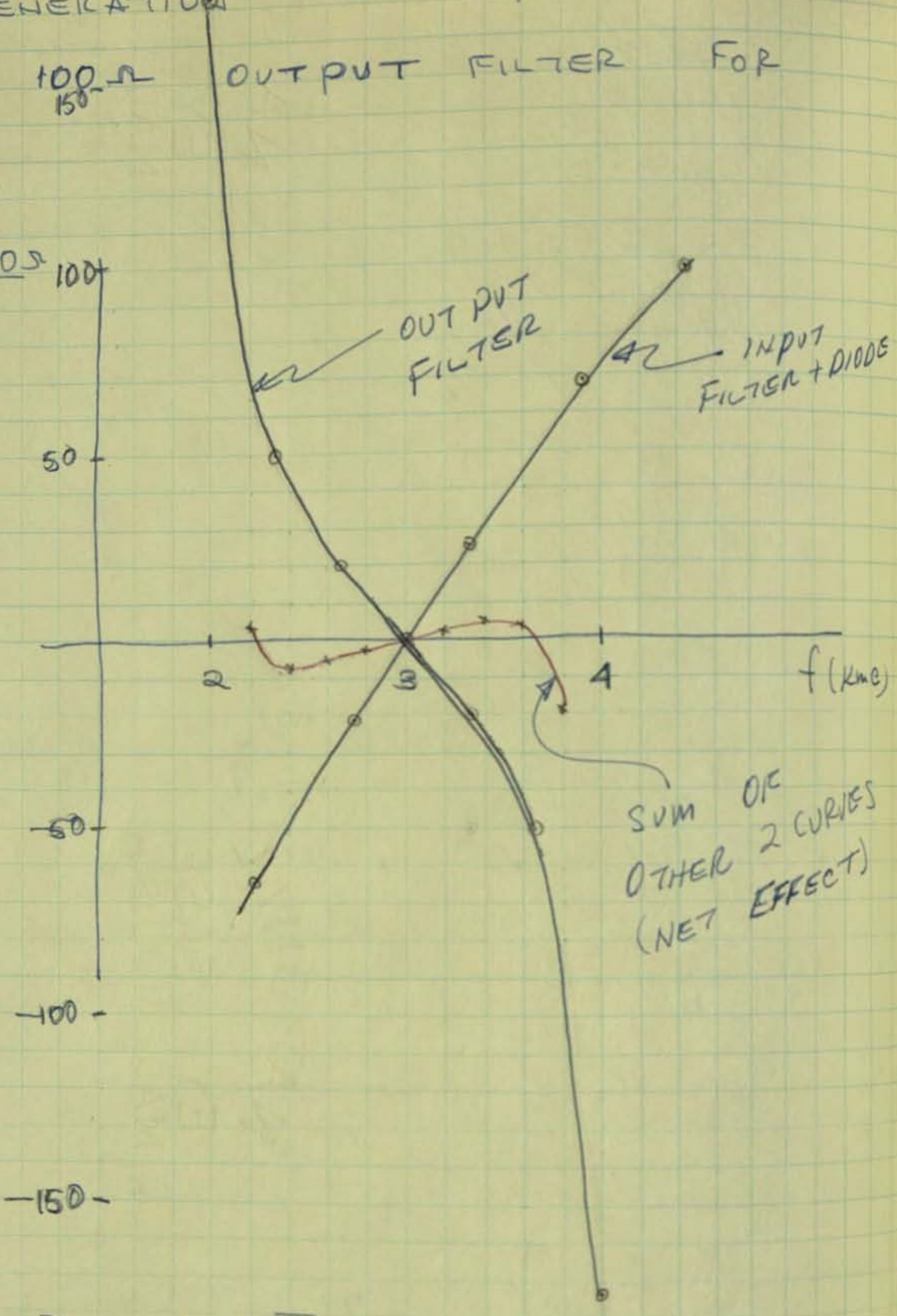
CONSIDER $f_0 = 3.5$ Kmc., $l = \frac{1}{4}\,\frac{3\times10^{10}}{3.5\times10^{9}\ 2.54} = .843$

HARMONIC GENERATION 7/31/62

CONSIDER A $\underset{150}{100}\,\Omega$ OUTPUT FILTER FOR DOUBLER.

SEE p. 29, 28

f (kmc.	COLUMN B x 100Ω
2.0	+j173
2.33	105 +j50
2.67	102 +j20
3.00	100
3.33	102 -j20
3.67	105 -j50
400	-j173



PLOT OF IMAGINARY PARTS OF OUTPUT CIRCUIT.

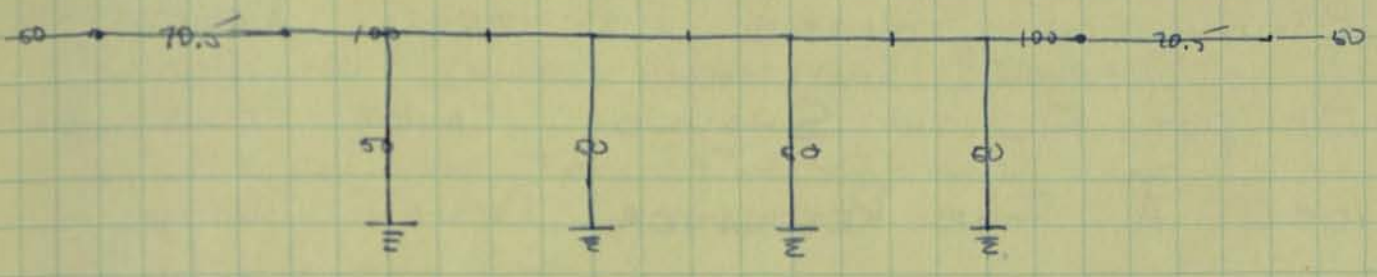
OUTPUT SHOULD WORK PRETTY WELL FROM 2.2 kmc TO 3.8 kmc.

CONT. FROM p. 44 7/31/62

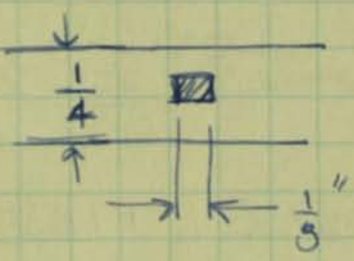
$$l = \frac{\lambda}{4} = \frac{1}{4}\,\frac{3\times10^{10}}{(2.54)(3\times10^{9})} = .984 \text{ in}$$

WILL TRY SINGLE GEOMETRIC MEAN MATCHING IMPED.

$$Z_m = \sqrt{50\cdot100} = 50\sqrt{2} = 70.5$$

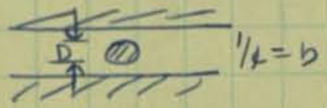


FOR 50 Ω.



FOR

FOR 70.5 Ω LINE



$$\frac{D}{b} = .39 \qquad D = \frac{.390}{4} = .0975$$

FOR 100 Ω LINE $\frac{D}{b} = .235$, $D = \frac{.235}{4}$ " $\doteq .060$ " $\doteq \frac{1}{16}$

April 10, 1963

FIFTH ORDER HARMONIC GENERATOR FOR SOLID STATE SOURCE.

OUTPUT FILTER

SINCE THE FIRST EFFORT WILL BE A 10% BANDWIDTH SOURCE CENTERED ABOUT 5.5 kmc THE OUTPUT FILTER SHOULD COVER THIS BAND. CONSIDER A FOUR RESONATOR DESIGN WITH .1 DB RIPPLE FOR TCHEB. DESIGN.

FROM GETSINGER:

1.0880 : 1.3061 : 1.7703 : 0.8189 {g VALUES}

FOR r = 0.7378

BEFORE THE ABOVE DESIGN IS CONSIDERED WILL SCALE THE 50 Ω DESIGN DONE AT S.R.I.

WILL CUT GROUND PLANE SPACING BY $\frac{1}{3}$

$b = \frac{1}{3} \times .625 = .208$

$t = \frac{1}{3} \times .187 = .062 \sim \frac{1}{16}$ STOCK

THEN IF $\frac{1}{4}$ STOCK IS USED FOR COVER PLATES THE SPACERS BETWEEN & LINES AND GROUND PLANES WILL BE $\frac{1}{2}(.208 - .062) = .073$

CONT. FROM p. 46 4/11/63

RECOPYING TABLE FROM MATTHAEI - PGMTT
NOV. 62 & DIVIDING BY 3

k	$S_{k,k+1}$	k	W_k
0 & 6	.042	0 & 7	.146
1 & 5	.140	1 & 6	.051
2 & 4	.171	2 & 5	.061
3	.173	3 & 4	.061

$$\begin{array}{r} 1.63 \\ 1.49 \\ \hline 3.12 \end{array}$$

EXISTING BAND CENTER SEEMS TO BE $\frac{1.63+1.49}{2}$ = 1.56 KMC

TRY SCALING TO 5.4 - 5.9 KMC BAND

$f_0 = 5.65$ KMC

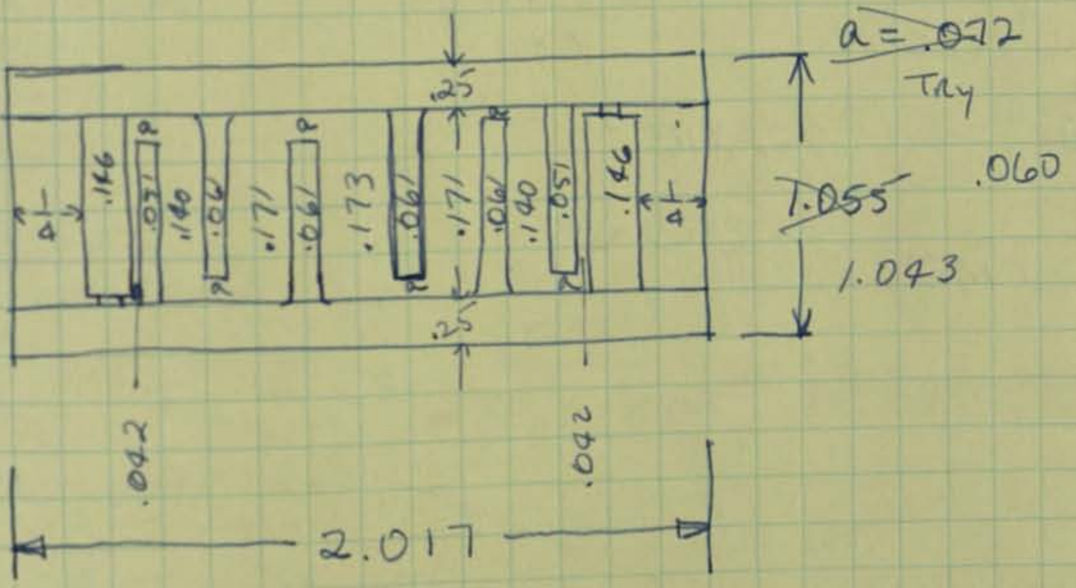
$$\begin{array}{r} 5.4 \\ 5.9 \\ \hline 2\,|\,11.3 \\ 5.65 \end{array}$$

$$\frac{\ell}{1.75} = \frac{\cancel{5.65}}{\cancel{1.816}} \; \frac{1.56}{5.65} \quad \cancel{\ell = .633}$$

$\ell = .483$, ALSO, SCALING END SPACINGS:

$$\frac{.216}{3} = .072$$

DIMENSIONS BECOME:-



$$\begin{array}{r} \cancel{1}.146 \\ .146 \\ .25 \\ .25 \\ .084 \\ .102 \\ .28 \\ .122 \\ .342 \\ .122 \\ .173 \\ \hline \cancel{2.773} \\ 2.017 \end{array}$$

$$\begin{array}{r} .483 \\ .072 \\ .500 \\ \hline 1.055 \\ -.012 \\ \hline 1.043 \end{array}$$

APRIL 18, 63 INPUT FILTER FOR HARM. GEN.

WILL TRY STYCAST #9 AS DIELECTRIC SUPPORT.

CONSIDER ALSO $\frac{1}{4}''$ GROUND PLANE SPACING.

<u>50 Ω LINE</u> FOR .003 COPPER FOIL

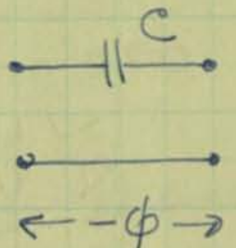
$$\frac{t}{b} = \frac{.003}{.250} = .012$$

$$50\sqrt{\epsilon_r} = 150\Omega. \;, \; \frac{W}{b} \approx .2 \;, \; W = \frac{.2}{4} = \underline{.050}$$

CONSIDER CENTER FREQ. OF $f_0 = 1100$ mc.

$$\lambda = \frac{3\times10^{10}}{(3)(1.1\times10^{9})(2.54)} = 3.58'' \text{ IN } K-9$$

CONSIDER IMPEDANCE INVERTER AT 1100 mc.



IF $C \approx 1$ pf.

$B = \omega C$

$= 2\pi \times 1.1\times10^{9}\times1\times10^{-12}$

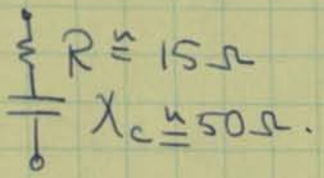
$B = 2.2\pi\times10^{-3} = 6.9\times10^{-3}$

$X = \frac{1000}{6.9} = 145$

4 | 24 | 63 CONTINUED FROM p. 48

CONSIDER A SHUNT DIODE HOOK-UP.

STARTING FROM HENSCHKE'S MEASURED VALUES AT 1.5 Kmc. :



$$Y = \frac{1}{Z} = \frac{1}{R - jX_c} \cdot \frac{R + jX_c}{R + jX_c} = \frac{R}{R^2 + X_c^2} + j\frac{X_c}{R^2 + X_c^2}$$

$$\therefore \quad G = \frac{R}{R^2 + X_c^2} \quad , \quad B = \frac{X_c}{R^2 + X_c^2}$$

$$\& \ R^2 + X_c^2 = 225 + 2500 = 2{,}725$$

at 1Kmc.

$$G = \frac{15}{2725} \qquad \& \qquad B = \frac{50}{2725}$$

$$\frac{1}{G} = 182\,\Omega : \qquad \frac{1}{B} = 55.5\,\Omega$$

CONSIDER 10% BANDWIDTH VALUES AROUND 1.5 Kmc. $f_1 = 1.35$ Kmc. & $f_2 = 1.65$ Kmc.

$$\frac{1}{G} = \frac{R^2 + \left(\frac{1}{\omega C}\right)^2}{R} = R + \frac{1}{R}\left(\frac{1}{\omega C}\right)^2$$

TO FIND C : at 1.5Kmc. $\omega C = \frac{1}{55.5} = .018$

$$C = \frac{.018}{2\pi\ 1.5 \times 10^9} = \frac{1.8 \times 10^{-11}}{3.0\pi}$$

$$C = \underline{1.91\ pf.}$$

AT $f_1 = 1.35$ Kmc.

$$\left.X_c\right|_{f_1} = 62.2$$

$$\left.\frac{1}{G}\right|_{f_1} = 15 + \frac{1}{15}\left(\frac{1}{2\pi\ 1.35 \times 10^9\ \ 1.9 \times 10^{-12}}\right)^2 = 15 + \frac{1}{15}\left(\frac{10^{+3}}{16.1}\right)^2$$

$$= 15\Omega + 257\Omega = \underline{272\,\Omega}$$

$$\begin{array}{r} 257 \\ 15 \\ \hline 272 \end{array}$$

4/24/63 CONT. FROM p. 49

$$\frac{1}{B} = \frac{R^2 + X_c^2}{\cancel{R}X_c} = \frac{R^2}{X_c} + X_c = \frac{(15)^2}{62.2} + 62.2$$

$$\left.\frac{1}{B}\right|_{f_1} = 3.62 + 62.2 = \underset{\sim\sim}{65.8\,\Omega}$$

AT $f_2 = 1.65$ Kmc

$$X_c = \frac{1}{\omega C} = \frac{1}{2\pi\,(1.65\times10^9)\,(1.91\times10^{-12})}$$

$$\frac{1000}{(2\pi)(1.65)(1.91)}$$
$1.5 \quad 2$
$$\cong \frac{1000}{20} = 50$$

$X_c = 50.5$, $X_c^2 =$ ~~2550~~ 2550

$$\left.\frac{1}{G}\right|_{f_2} = 15 + \frac{1}{15}(2550) = 15 + 170 = \underset{\sim\sim}{185\,\Omega.}$$

$$\left.\frac{1}{B}\right/_{f_2} = \frac{225}{50.5} + 50.5 \doteq 4.5 + 50.5 = \underset{\sim\sim}{55\,\Omega.}$$

	$\frac{1}{G}$	$\frac{1}{B}$
f_1	272	65.8
~~f_1~~ f = 1.4 Kmc	251	63.3
f_0	182	55.5
f = 1.6 Kmc	195	56.0
f_2	185	~~60.5~~ 55.0

For f = 1.60 Kmc $X_c = 52.0$ $X_c^2 = 2710$

$$\frac{1}{G} = 15 + \frac{1}{15}\,2710 = 15 + 180 = 195\,\Omega.$$

$$\frac{1}{B} = \frac{225}{52} + 52 = 4.33 + 52 = 56\,\Omega.$$

For f = 1.40 Kmc, $X_c = 59.5$, $X_c^2 = 3540$

$$\frac{1}{G} = 15 + \frac{1}{15}\,3540 = 15 + 236 = \underset{\sim\sim}{251\,\Omega}$$

$$\frac{1}{B} = \frac{225}{59.5} + 59.5 = 3.8 + 59.5 = \underset{\sim\sim}{63.3\,\Omega.}$$

4/24/63 CONT. FROM p. 50

CONSIDER SITUATION AT 1.0 Kmc – 1.2 Kmc.

$$\frac{1000}{12}$$

@ 1.0 Kmc.

$$\frac{1}{wC} = \frac{1}{2\pi\ 10^9\ 1.91 \times 10^{-12}} = 83.4$$

$$\left(\frac{1}{wC}\right)^2 = 6950$$

$$\frac{1}{G} = 15 + \frac{1}{15}\ 6950 = 15 + 463 = \underline{478\ \Omega}$$

$$\frac{1}{B} = \frac{225}{83.4} + 83.4 = 2.7 + 83.4 = \underline{86.1\ \Omega.}$$

@ 1.1 Kmc

$$\frac{1}{wC} = 75.8\ ,\ \left(\frac{1}{wC}\right)^2 = 5750$$

$$\frac{1}{G} = 15 + \frac{1}{15}(5750) = 15 + 383 = \underline{398\ \Omega.}$$

$$\frac{1}{B} = \frac{225}{75.8} + 75.8 = 3.0 + 75.8 = \underline{78.8\ \Omega}$$

@ 1.2 Kmc.

$$\frac{1}{wC} = \frac{1}{2\pi\ 1.2 \times 10^9\ 1.91 \times 10^{-12}} = 69.5$$

$$\left(\frac{1}{wC}\right)^2 = 4830$$

$$\frac{1}{G} = 15 + \frac{1}{15}(4830) = 15 + 322 = \underline{337\ \Omega}$$

$$\frac{1}{B} = \frac{225}{69.5} + 69.5 = 3.25 + 69.5 \cong \underline{72.8\ \Omega}$$

5/7/63 INPUT FILTER DESIGN

START WITH $f_1 = 1000$ mc. $f_2 = 1.2$ Kmc

1.0 Kmc

FOR $n=5$ $\quad n f_1 = 5.00$ Kmc, $n f_2 = 6.0$ Kmc.

NEAREST SIDE BAND OCCUR AT

$$\frac{2}{2n+1} = \frac{2}{11} = 18\%$$

$$\omega_0 = 2\frac{\omega_a \omega_b}{\omega_b + \omega_a}$$

$$\cancel{2\pi}\, f_0 = \cancel{2} \cdot \frac{\overset{2}{\cancel{4}}\cancel{\pi^2} f_a f_b}{\cancel{2\pi}(f_a + f_b)}, \quad f_0 = \frac{2 f_a f_b}{f_a + f_b}$$

$$f_0 = \frac{(1.0)(1.2)}{2.2} = 1.09 \text{ Kmc.}$$

USING 5.4 Kmc TO 5.9 Kmc ON OUTPUT.

$$\cancel{f_0} \cdot \frac{5.4}{5} = 1.08 \text{ Kmc} \qquad \frac{5.9}{5} = 1.18 \text{ Kmc}$$

$$f_0 = \cancel{2}\frac{(1.08)(1.18)}{\overset{\cancel{2.26}}{1.13}} = 1.13 \text{ Kmc.}$$

FOR .2 db RIPPLE, $g_0 = 1$, $g_5 = \frac{1}{.6499} = 1.54$

$g_1 = 1.3028$, $g_2 = 1.2844$, $g_3 = 1.9761$, $g_4 = .8468$

$$\delta = \omega_1'\left(\frac{\omega_b + \omega_a}{\omega_b - \omega_a}\right) = 1\left(\frac{2.2}{.2}\right) = 11.0$$

$$\frac{J_{01}}{Y_0} = \sqrt{\frac{\pi}{2\delta g_0 g_1}} = \sqrt{\frac{\pi}{(2)(11)(1.30)}} = \sqrt{.11}$$

$$\frac{J_{01}}{Y_0} = .332$$

5/7/63 CONT. FROM p. 52

$$\frac{B_{01}}{Y_0} = \frac{J/Y_0}{1-(J/Y_0)^2} = \frac{.332}{.890} = .373$$

$$\begin{array}{r} 1.000 \\ .110 \\ \hline .890 \end{array}$$

$$\underline{B_{01}} = \frac{.373}{15} = .0249$$

$$C_{01} = \frac{.0249}{(2\pi)(1.13\times10^9)} = \underline{3.5\ pf.}$$

ALSO $\frac{J_{45}}{Y_0} = \sqrt{\frac{\pi}{2\delta\, 1.3}} = \frac{J_{01}}{Y_0}$

$\therefore\ C_{45} = 3.5\ pf.$

$$\frac{K_{12}}{Z_0} = \frac{\pi}{2\delta\sqrt{g_1g_2}} = \frac{\pi}{22\sqrt{(1.30)(1.28)}} = \frac{\pi}{(22)(1.29)}$$

$\frac{K_{12}}{Z_0} = .111$, $\left(\frac{K_{12}}{Z_0}\right)^2 = .0122$

$$\begin{array}{r} 1.000 \\ .012 \\ \hline .988 \end{array}$$

$$\frac{X_{12}}{Z_0} = \frac{K_{12}/Z_0}{1-\left(K_{12}/Z_0\right)^2} = \frac{.111}{.989} = \underline{.112}$$

WITH $Z_0 = 15\,\Omega$ $X_{12} = 1.68$

$$L_{12} = \frac{1.68}{(2\pi)1.13\times10^9} = \frac{1680}{2.26\pi}\times10^{-12}$$

$$L_{12} = .237\ \underline{nh.}$$

$$\frac{J_{23}}{Y_0} = \frac{\pi}{2\delta\sqrt{g_2g_3}} = \frac{\pi}{22\sqrt{(1.28)(1.97)}} = \frac{.143}{\sqrt{2.52}} = \frac{.143}{1.59}$$

$$\begin{array}{r} 1.000 \\ .009 \\ \hline .992 \end{array}$$

$\frac{J_{23}}{Y_0} = .089$, $\frac{B_{23}}{Y_0} = \frac{.089}{.992} = .091$

$B_{23} = \frac{.091}{15} = .006$, $C_{23} = \frac{.006}{(2\pi)1.13\times10^9} = \frac{6.\times10^{-12}}{2.26\pi}$

$C_{23} = \underline{.85pf.}$

CONT. FROM p. 53 5/8/63

FOR 15 Ω LINE IN K-9

$\sqrt{\epsilon_r}\ 15 = 45\Omega$

$\frac{W}{b} = 1.6$ WITH $b = \frac{1}{4}$

$W = .4$

WITH $b = \frac{1}{8}$ $\underset{\sim}{W = .2}$

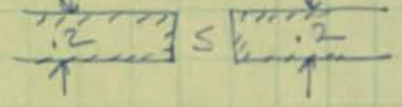
FOR 1 STEP TRANSFORMER BETWEEN 50Ω & 15Ω

$Z_m = \sqrt{50 \cdot 15} = 5\sqrt{30} = \underset{\sim}{27.4\Omega}$

$\sqrt{\epsilon}\ 27.4 = 82.5$

$W/b = .67$ $W = \frac{.670}{8} = \underset{\sim}{.084}$

TO CALCULATE DIMENSIONS OF $C_{23} = .0.85\,pf.$



$\epsilon = .0885\ \epsilon_r\ pf/cm.$

$\epsilon_r = 9\ ,\ \epsilon = .7965$

$C_{f_0} = \frac{.85}{(.2)(2.54)} = 1.67\ pf/cm$

$\therefore \frac{C_{f_0}}{\epsilon} = \frac{1.67}{.80} = 2.1$

FROM COHN'S ODD MODE GRAPH

$\frac{S}{b} = .025$

$S = \frac{.025}{8} \approx \underset{\sim}{.003}$

TO CALCULATE DIMENSIONS OF 3.5 pf (USING t=.005 TEFLON)

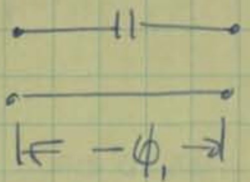
$C = \frac{.225\ A\ k}{t}\ pf$ $A = \frac{C\,t}{.225\,k} = \frac{3.5 \times \text{[illegible]}\ .005}{(.225)(2.1)}$

$A = \frac{17.5 \times 10^{-3}}{(.225)(2.1)} = .037\ in^2$

FOR A .002 THICKNESS

$A = 37 \times 10^{-3} \times \frac{2}{5} = .015\ m^2$

TO CALCULATE LINE LENGTHS.

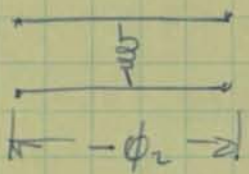


$\frac{J_{01}}{Y_0} = \tan^{-1} \frac{\phi_1}{2} = .332$

$\frac{\phi_1}{2} = 18.35°$ $\phi_1 = 36.7°$

$\frac{360°}{36.7} = \frac{3.58}{x}$, $x = \underline{.365}''$ $\frac{x}{2} = \underline{.182}''$

FOR K INVERTER



$\tan \frac{\phi_2}{2} = .111$

$\frac{\phi}{2} = 6.4°$, $\phi = 12.8°$

$\frac{360}{12.8} = \frac{3.58}{x_2}$, $\underline{x_2 = .127}$, $\frac{x_2}{2} = \underline{.063}$

$\frac{\lambda}{2} = \frac{3.58}{2} \frac{1.10}{1.13} = \underline{1.75}$, $\underline{\frac{\lambda}{4} = .88}$

$.182$

$l = \frac{\lambda}{2} - \frac{x_1}{2} - x_2 = 1.75 - \frac{.365}{2} - .127$

$l =$

$= \underline{1.44}$

~~.367~~
~~.127~~
~~.492~~

~~1.750~~
~~.492~~
~~1.258~~

.182
.127
.309

1.75
.31
1.44

TO CALCULATE INDUCTANCE DIMENSIONS.

$L = .237\ \mu h$

USING STUB OF $Z = 15\Omega$.

$\frac{X_{12}}{Z_0} = .112 = \tan \theta$

$\theta = 6.4°$, $\therefore l \doteq 1/16$

IF $l = 1/8$, $\theta = 12.6°$, $\{ \tan \theta = .223 = \frac{X}{Z_0}$

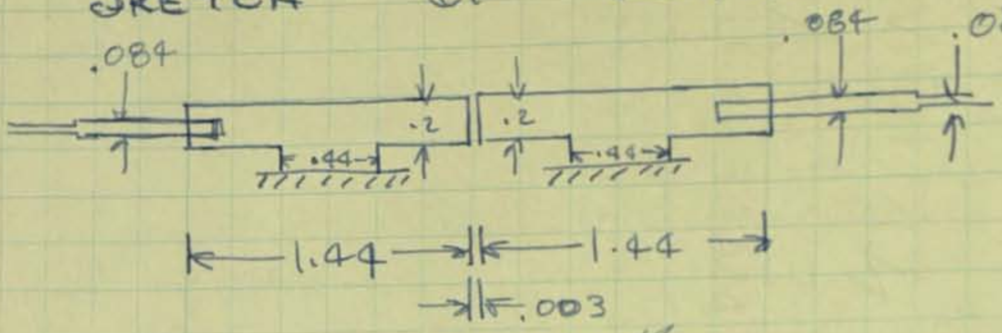
$Z_0 = \frac{X}{.223} = \frac{1.68}{.223} = 7.54\Omega$, $\sqrt{\varepsilon_r}\ 7.54 = \underline{22.6}\ \Omega$.

$\frac{W}{b} = 3.55$ $W = \frac{3.55}{8} = \underline{.444}$

5/8/63 CONT. FROM p. 55.

SKETCH OF DESIGN

FOR 50Ω LINE IN K-9



CONSIDER A 2 ~~6~~ RESONATOR DESIGN WITH FOLLOWING

PROPERTIES:- $f_1 = 900$ mc $f_2 = 1000$ mc

HARMONIC $n=6$

$nf_1 = 5400$ mc $nf_2 = 6000$ mc

$$f_0 = 2\frac{f_1 f_2}{f_1+f_2} = \frac{2(.9)(1.0)}{1.9} = \frac{1.8}{1.9} \simeq \underline{.95\text{ kmc}}$$

$$\delta = \omega_1'\left(\frac{\omega_2+\omega_1}{\omega_2-\omega_1}\right) = \frac{1.0+.9}{.1} = \underline{19}$$

FOR 2 SECTIONS · WITH .2 db RIPPLE

$$g_0 = 1,\quad g_1 = 1.038,\quad g_2 = .675,\quad g_3 = \frac{1}{.650} = 1.54$$

$$\frac{J_{01}}{Y_0} = \sqrt{\frac{\pi}{2\delta g_0 g_1}} = \sqrt{\frac{\pi}{2\cdot 19\cdot 1.04}} = \sqrt{.0795}$$

$$\frac{J_{01}}{Y_0} = \underline{.282}$$

$$\begin{array}{r} 1.000 \\ .080 \\ \hline .920 \end{array}$$

$$\frac{B_{01}}{Y_{01}} = \frac{J_{01}/Y_0}{1-\left(\frac{J_{01}}{Y_0}\right)^2} = \frac{.282}{.920} = .306$$

FOR $Z_0 = 15\,\Omega$

$$B_{01} = \frac{.306}{15} = .0204$$

$$\frac{20}{6}$$

$$C_{01} = \frac{.0204}{2\pi\cdot .95\times10^9} = \underline{3.42\text{ pf.}}$$

5/16/63 CONT. FROM p. 56

$$\frac{K_{12}}{Z_0} = \frac{\pi}{2\delta\sqrt{g_1 g_2}} = \frac{\pi}{38\sqrt{(1.04)(.675)}} = \frac{\pi}{38\sqrt{.702}} = \frac{\pi}{(38)(.84)}$$

$$\frac{K_{12}}{Z_0} = .0985 \quad , \quad \left(\frac{K_{12}}{Z_0}\right)^2 = .0097$$

$$\begin{array}{r} 1.0000 \\ .0097 \\ \hline .9903 \end{array}$$

$\frac{3}{35} \approx \frac{1}{12}$

$$\frac{X_{12}}{Z_0} = \frac{K_{12}/Z_0}{1 - \left(\frac{K_{12}}{Z_0}\right)^2} = \frac{.0985}{.9903}$$

$$\frac{X_{12}}{Z_0} = .099$$

FOR $Z_0 = 15\,\Omega$.

$$X_{12} = 1.49\,\Omega \quad , \quad L = \frac{1.49}{2\pi(.95)\times 10^9} = \underline{.25\ nh}$$

FOR $Z_0 = 50\,\Omega$.

$$\frac{B_{01}}{Y_0} = .306 \quad , \quad B_{01} = \frac{.306}{50} = .00612 \quad , \quad \frac{1}{B_{01}} = 163\,\Omega.$$

$$C_{01} = \frac{.006}{2\pi(.95)\times 10^9} = \underline{1.03\ pf.}$$

$$\frac{X_{12}}{Z_0} = .099 \quad , \quad X_{12} = 4.95\,\Omega$$

$$\underline{L = .83\ nh}$$

FOR $100\,\Omega$
$C_{01} = .51\ pf. \quad L = 1.66\ nh$

TO REALIZE C_{01}

$$C = \frac{.225\,k\,A}{t} \quad , \quad \frac{A}{t} = \frac{C}{.225\,k} = \frac{1.03}{(.225)(\underset{\uparrow}{2.1})} = 2.18$$

TEFLON

FOR $t = .005$

$A \cong .011$

$\underline{\sqrt{A} = .105}$

OR $\pi R^2 = .011$

$R^2 = .0035$

$\underline{R = .059}$

FOR MYLAR $k = 3.0$

$\frac{A}{t} = 1.53$ FOR $t = .005$

$A = .00763$

$\sqrt{A} = .087$

5/17/63 CONT. FROM p. 57

FOR $L = .83$ nh
TRY SHORTED LINE WITH $Z_0 = 30\Omega$.

$$\omega L = Z_0 \tan\phi$$

$$\tan\theta = \frac{\omega L}{Z_0} = \frac{\cancel{2}\pi(.95\times10^{9})(.83\times10^{-9})}{\cancel{30}\ 15} = \frac{\pi(.95)(.83)}{15}$$

$$\tan\theta = .165 \ , \quad \underline{\theta = 9.4^\circ}$$

$$\lambda_{@.95\text{kmc IN K-9}} = \frac{\cancel{3}\times10^{10}}{(.95\times10^{9})(\cancel{3})(2.54)} = \frac{10}{(.95)(2.54)} = \underline{4.15}$$

$$\frac{360}{4.15} = \frac{9.4}{x} \ , \quad \underline{x = .108}$$

$$\sqrt{\epsilon_r}\ 30 = 90\Omega. \ , \quad \frac{w}{b} = .58$$

$$\text{For } b = \frac{1}{4} \ , \quad \underline{w = .145}$$

TRY $Z = 15\Omega$ THEN $w = .4$

$$\tan\theta = .165 \quad \frac{30}{15} = .330$$

$$\theta = 18.3^\circ \qquad \frac{360^\circ}{4.15} = \frac{18.3}{x}$$

$$\underline{x = .211}$$

TO GET NEGATIVE LINE LENGTHS

$$\tan\phi_1 = \frac{2B}{Y_0} = (2)(.306) = .612$$

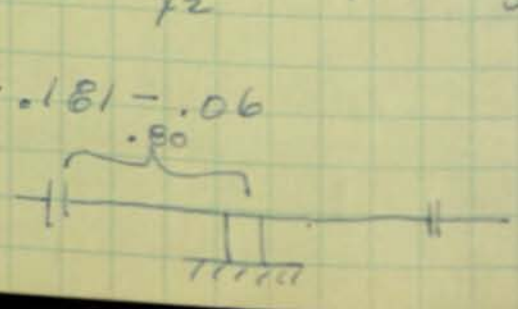
$$\phi_1 = 31.5^\circ \ , \quad \frac{360}{4.15} = \frac{31.5}{x_1} \ , \quad x_1 = \underline{.363}$$

$$\tan\phi_2 = \frac{2X}{Z_0} = (2)(.099) = .198$$

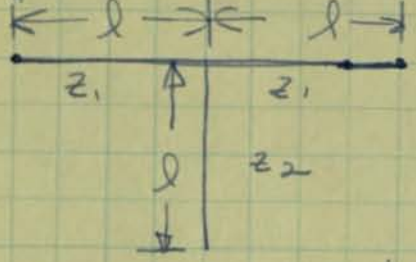
$$\phi_2 = 11.2^\circ \ , \quad \frac{360}{4.15} = \frac{11.2^\circ}{x_2} \ , \quad x_2 = \underline{.129}$$

$$l = \frac{\lambda}{4} - \frac{x_1}{2} - \frac{x_2}{2} = 1.04 - .181 - .06$$

$$l = \underline{.80}$$



CONSIDER FILTER TYPES TO STOP SPURIOUS RESPONSES at 3rd AND 5th HARM.



$R_i = \frac{Z_1}{\sqrt{1+\rho}}$, $\rho = \frac{Z_1}{Z_2}$

IF $Z_1 = R_i = 50\Omega$.

$\sqrt{1+\rho} = 1$, NO GOOD!

TRY $R_i = 50\Omega$. & $\rho = 1$

$Z_1 = (1.414)(50) = \underline{70.7\Omega}$.

ALSO, CONSIDER DESIGN WITH STOPBAND CENTERED AT 6.0 KMC OR BETTER $f_1 = 2.5$ KMC

AND $f_2 = 4 f_1 = 10$ KMC ∴ $f_0 = \frac{12.5}{2} = 6.25$ KMC.

$A = 1 - (2+\rho)\sin^2\phi$

$-1 = 1 - (2+\rho)\sin^2\phi_1$

$2+\rho = \frac{2}{.346} = 5.78$

$\underline{\rho = 3.78}$

$\frac{6.25}{90^\circ} = \frac{2.5}{\phi_1}$

$\phi_1 = 36^\circ$

$\sin 36^\circ = .588$

$\sin^2 36^\circ = .346$

∴ $Z_1 = R_i\sqrt{1+\rho} = \cancel{R_i}\, 50\sqrt{4.78} = (50)(2.18)$

$\underline{Z_1 = 109\Omega}$. , $Z_2 = \frac{Z_1}{\rho} = \frac{327}{3.78} = 86.5$

IN K-9 $\sqrt{\epsilon_r}\, Z_1 = 327\Omega. \rightarrow$ TOO LARGE

5/21/63 CONT. FROM p. 59

TRY $f_0 = 5.0$ Kmc WITH $f_1 = 2.5$ Kmc, $f_2 = 7.5$ Kmc

$A = 1 - (2+\rho)\sin^2\phi$

$\frac{5.0\text{ Kmc}}{90^\circ} = \frac{2.5\text{ Kmc}}{x}$

$x = 45^\circ$

$\sin x = \frac{1}{\sqrt{2}}$

$\sin^2 x = \frac{1}{2}$

$-1 = 1 - (2+\rho)\frac{1}{2}$

$-2 = 2 - (2+\rho)$

$\rho = 2$

~~A~~ $\therefore Z_1 = 50\sqrt{1+\rho} = 50\sqrt{3}$

$Z_1 = 86.5\ \Omega$ $Z_2 = \frac{Z_1}{\rho} = \frac{86.5}{2} = 43.25$

$\sqrt{\epsilon_r}\, Z_1 = 259\ \Omega.$ $\sqrt{\epsilon_r}\, Z_2 = 130\ \Omega.$

$\frac{w_1}{b} \cong .04$ $\frac{w_2}{b} = .28$

$w_1 \cong .010$ $w_2 = .070$

TO CALCULATE PHASE SHIFT AT .95 Kmc PER SECTION. (β)

IN THE PASS BAND $\cos\beta = 1 - 4\sin^2\phi$

$\cos\beta = 1 - .346$

$$\begin{array}{r} 1.000 \\ .346 \\ \hline .654 \end{array}$$

$\frac{5.0}{90^\circ} = \frac{.95}{y}$

$\cos\beta = .654$

$y = 17.1^\circ$

$\beta = 49.1^\circ$ PER SECTION

$\sin 17.1' = .294$

CORRESPONDS TO $2x = 34.2^\circ$ OF STRAIGHT TRANS. LINE.

$\sin^2 17.1^\circ = .086$

$\lambda = 4.15'$ IN K-9 AT .95 Kmc
CORRESPONDS TO 360°

$\frac{360^\circ\ \cancel{180^\circ}}{4.15''} = \frac{49.1^\circ}{x}$, $x =$ ~~.204~~ .566"

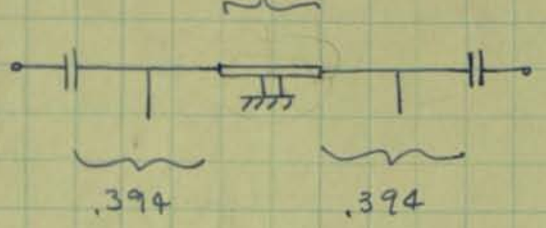
BUT $l = \frac{\lambda}{4}$ @ 5.0 Kmc IN K-9 $= \frac{1}{4}\,\frac{3\times10^{10}}{(3)(5\times10^{9})\,2.54} = .197$

$2l = .394''$

5/21/63 CONT. FROM p. 59

~~$\frac{.566}{.394} = \frac{.8}{x}$, $x = .557$~~

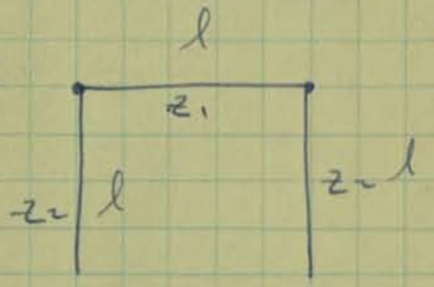
POSSIBLE $\underbrace{.468}$ HOOKUP:



.800
~~.394~~

$$\begin{array}{r} .800 \\ .566 \\ \hline .234 \\ 2 \\ \hline .468 \end{array}$$

CONSIDER ANOTHER FILTER TYPE:



$A = \cos\phi - \rho \sin\phi \tan\phi$

AGAIN, IF $f_0 = 5$ kmc.
& $f_1 = 2.5$ kmc, $f_2 = 7.5$ kmc

$\phi_1 = 45°$

$\therefore -1 = \frac{1}{\sqrt{2}} - \rho \frac{1}{\sqrt{2}} \cdot 1$, $-\sqrt{2} = 1 - \rho$, $\rho = 1 + \sqrt{2}$

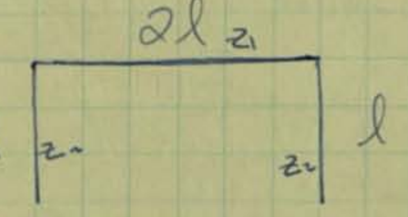
$\underbrace{\rho = 2.414}$

$R_{i_1} = \frac{Z_1}{\sqrt{1+2\rho}}$, $Z_1 = R_i \sqrt{1+2\rho}$

$Z_1 = 50\sqrt{5.83} = 121\ \Omega$. ← TOO LARGE

4.828
1

CONSIDER ALSO



$A = -\rho + (1+\rho) \cos 2\beta l$

$\rho = \frac{Z_1}{Z_2}$

$-1 = -\rho + (1+\rho)(0)$

For $f_0 = 5.0$ kmc., $f_1 = 2.5$ kmc.
$(\beta l)_0 = 90°$ $(\beta l)_1 = 45°$

$\underbrace{\rho = 1}$

$Z_{i_0} = \frac{Z_1}{\sqrt{1+\rho}}$

$Z_1 = 50\sqrt{2} \cong 71.\ \Omega$

$\sqrt{\epsilon_r}\, Z_1 = 213\ \Omega$

$\frac{w}{b} \cong .07$

$w = .\frac{07}{4} = \underbrace{.017}$

CONT. FROM p. 61 5/21/63

TO CALCULATE PHASE SHIFT θ THRU ONE SECTION AT 950 mc

$$A = -\rho + (1+\rho)\cos 2\beta l$$

SINCE $\rho = 1$

$$\cos\theta = -1 + 2\cos 2\beta l$$

$$\cos\theta = -1 + 1.654$$

$$\cos\theta = .654$$

$$\theta = 49.1^\circ$$

$5.0\text{ kc} \approx \beta l = 90^\circ$

$$\frac{5.0}{.95} = \frac{90^\circ}{(\beta l)_{.95}}$$

$$(\beta l)_{.95} = 17.1^\circ$$

$$2\beta l = 34.2$$

$$\cos 34.2^\circ = \begin{array}{r} .827 \\ 2 \\ \hline 1.654 \end{array}$$

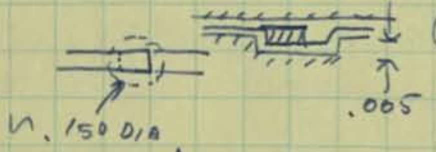
CONSIDER DESIGN OF BANDPASS FILTER USING REXOLITE. 1422.

FOR 50Ω LINE: $\epsilon_r = 2.54$, $\sqrt{\epsilon_r} \approx 1.6$, $\frac{t}{b} = \frac{.002}{.25} = .008$

$\sqrt{\epsilon_r}\,50 = 80$, $\frac{w}{b} = .72$, $w = \frac{.72}{4} = \underset{\sim}{.180}$

OR $b = \frac{1}{8}$, $w = .090$

CONSIDER CAPACITY OF .090 SQUARE WITH SPACING OF .003 MYLAR



$$C = \frac{(.225)(2.9)(.090)^2}{.003} = \frac{(.225)(2.9)\,81}{30} = \underset{\sim}{1.176}$$

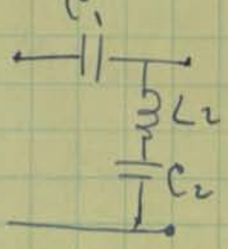
AS TO LINE LENGTHS

$$\frac{l_1}{l_2} = \frac{\sqrt{\epsilon_{r_2}}}{\sqrt{\epsilon_{r_1}}}, \quad \frac{.85}{l_2} = \frac{1.6}{3}, \quad l_2 = \underset{\sim}{1.59}$$

6/10/63

CONSIDER HIGH PASS FILTER DESIGN.
(AT LEAST ADDING M DERIVED SECTION TO AN EXISTING CONSTANT K DESIGN.)

$f_c = 700$ mc. & $R = 50\Omega$



$$R = \sqrt{\frac{L_k}{C_k}} \quad , \quad 2\pi f_c = \frac{1}{\sqrt{L_k C_k}}$$

$$L_k = R^2 C_k \quad , \quad L_k C_k = \frac{1}{4\pi^2 f_c^2}$$

THEN $R^2 C_k^2 = \frac{1}{4\pi^2 f_c^2}$

$$C_k = \frac{1}{2\pi R f_c} = \frac{1}{2\pi (50)(.7\times10^9)} = \frac{10^{-11}}{.7\pi}$$

$C_k = \underline{4.55}$ pf.

$L_k = (2500)(4.55)\times10^{-12}$

$\underline{L_k = 11.4 \text{ nh.}}$

DESIRE $\omega_\infty = ~~4~~ \, 2\pi f_\infty = 2\pi \; .475$ kmc

$\omega_\infty = 29.8$

$$m = \sqrt{1 - \omega_\infty^2/\omega_c^2} = \sqrt{1 - \left(\frac{.475}{.700}\right)^2} = \sqrt{1 - .46}$$

$m = \sqrt{.54} = \underline{.735}$

$$\frac{m}{1-m^2} = \frac{.735}{1-.54} = \frac{.735}{.46} = \underline{1.6}$$

$C_1 = \frac{C_k}{m} = \frac{4.55}{.735} = \underline{6.2}$ pf

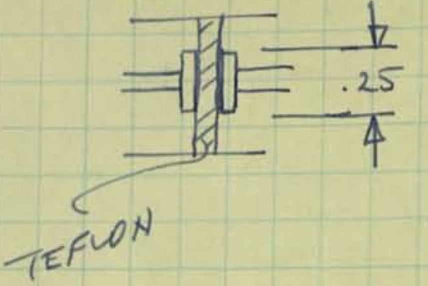
$L_2 = \frac{L_k}{m} = \frac{11.4}{.735} = \underline{15.5}$ nh

$C_2 = \frac{m}{1-m^2} C_k = 1.6 \, C_k = \underline{7.3}$ pf

CONT. FROM p. 63

6/10/63

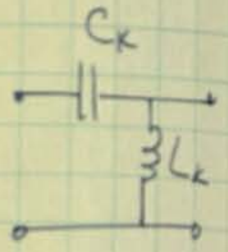
CONSIDER PHYSICAL SIZE. FOR $C_K = 4.55$ pf



$$C = \frac{.225 \, k \, A}{t} \quad , A = \pi \left(\frac{.25}{2}\right)^2$$

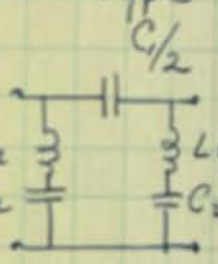
$$= \pi \, .0156$$
$$= .049$$

$$t = \frac{.225 \, k A}{C}$$



$$t = \frac{(.225)(2.1)(.049)}{4.55} = \underline{.0051}$$

WILL TRY A FILTER OF THIS TYPE:



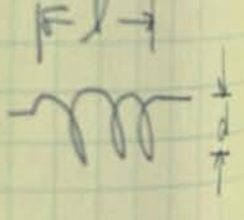
$\frac{C_1}{2} = \underline{3.1}$ pf

$L_2 = \underline{15.5}$ nh

$C_2 = \underline{7.3}$ pf.

PHYSICAL DIMENSIONS OF L_2

FROM TERMAN FOR SINGLE LAYER COIL



$L = F n^2 d$ μh.

TRY $\frac{d}{l} = 1.0$ THEN $F = .017$

{ LET $d = .2$

$L = .0034 \, n^2$, WITH $L = .0155$ μh

$$n^2 = \frac{.0155}{.0034} = 4.55$$

$\underline{n \simeq 2 \text{ TURNS}}$. ON .2 DIAM. ROD

SINCE C_1 WILL OCCUR IN SERIES WITH 50

LINE $\frac{D}{d} = 2.3$, $d = \frac{.375}{2.3} = .163$

CONT. FROM p. 64   6/11/63

PHYSICAL DIMENSIONS OF $C_{1/2}$ USING MYLAR $\epsilon_r \cong 2.9$

$$C = \frac{.225 k A}{t}$$

$$t = \frac{(.225)(2.9)}{3.1}\pi\left(\frac{.163}{2}\right)^2 = \underset{\sim\sim}{.0044}$$

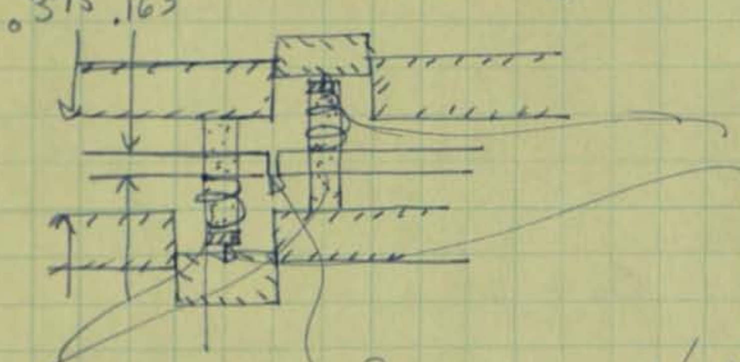
PHYSICAL DIMENSIONS OF C_2

TRY $\Omega = .2$

~~$t = .0044\left(\frac{.200}{.163}\right)^2 = (.0044)$~~

$$t = \frac{(.225)(2.9)\pi(.1)^2}{7.3} = \underset{\sim\sim}{.0028}$$

CONSTRUCTION



USE 2 TURNS OF #28 WIRE.

1 LAYER 2½ MILL MYLAR TAPE

2 LAYERS 2½ MILL MYLAR TAPE

.2 DIA.
REX ROD.

CONT. FROM p. 65

6/19/63

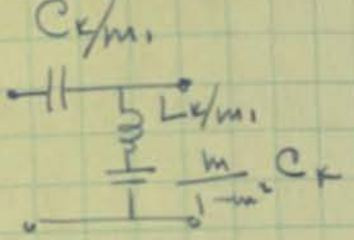
SINCE SPURIOUS SIGNALS OCCUR AT BAND EDGES - 5.4 Kmc AND 5.9 Kmc - REQUIRES 2 STOP BANDS - ONE AT $\frac{.9}{2} = .450$ Kmc AND $\frac{1.0}{2} = 5.0$ Kmc. RATHER THAN CENTERED AT .475 Kmc

FROM p. 63 VALUE OF m MUST CHANGE

For $w_\infty \overset{2\pi}{=} .450$ Kc

$$m_1 = \sqrt{1 - \left(\frac{\omega_\infty}{\omega_c}\right)^2} = \sqrt{1 - \left(\frac{.450}{.700}\right)^2} = \sqrt{1 - .413}\,, \quad \begin{array}{r} 1.000 \\ .413 \\ \hline .587 \end{array}$$

$$\underline{m_1 = .766}$$



$\{ \; C_K = 4.55$ pf.

$L_K = 11.4$ nh

$$\frac{m}{1-m^2} = \frac{.766}{1-.587}\,, \quad \begin{array}{r} 1.000 \\ .587 \\ \hline .413 \end{array}$$

$$= \frac{.766}{.413} = 1.85$$

$$\frac{C_K}{m_1} = \frac{4.55}{.766} = \underline{5.93} \text{ pf.}$$

$$\frac{L_K}{m_1} = \frac{11.4}{.766} = \underline{14.9 \text{ nh}}$$

$$\frac{m}{1-m^2} C_K = (1.85)(4.55) = \underline{8.4} \text{ pf.}$$

For $\omega_\infty = 2\pi\ .500$

$$m_2 = \sqrt{1 - \left(\frac{.500}{.700}\right)^2} = \sqrt{.49} = .70 \qquad \begin{array}{r} 1.00 \\ .51 \\ \hline .49 \end{array}$$

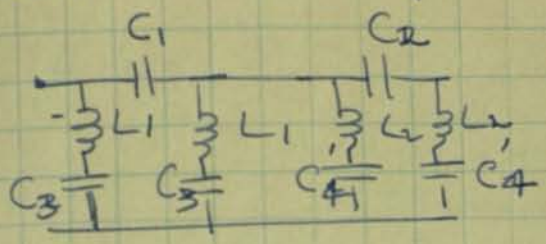
$$\frac{C_K}{m_2} = \frac{4.55}{.7} = \underline{6.5} \text{ pf.}$$

$$\frac{m_2}{1-m_2^2} = \frac{.7}{1-.49} = \frac{.7}{.51} = 1.37$$

$$\frac{L_K}{m_2} = \frac{11.4}{.7} = \underline{16.3} \text{ nh}$$

$$\frac{m_2}{1-m_2^2} C_K = (1.37)(4.55) = \underline{6.25} \text{ pf.}$$

CONT. FROM p. 66 6/19/63



$C_1 = \frac{5.93}{2} = \underline{2.97}$ pf.

$C_2 = \frac{6.5}{2} = \underline{3.25}$ pf

$C_3 = \underline{8.4}$ pf. $L_1 = \underline{14.9 \text{ nh}}$

$C_4 = \underline{6.25}$ pf. $L_2 = \underline{16.3 \text{ nh}}$

TO CALCULATE TURNS OF WIRE FOR L_1 & L_2

FOR L_1:

FOR $d = .25$ & $l = .25$

$L = .0034\ n^2$ FROM p. 64

$$n_1^2 = \frac{.0149}{.0034} = 4.38$$

$n_1 = 2.1$ TURNS. $\simeq$ $\underline{2 \text{ TURNS}}$

FOR L_2

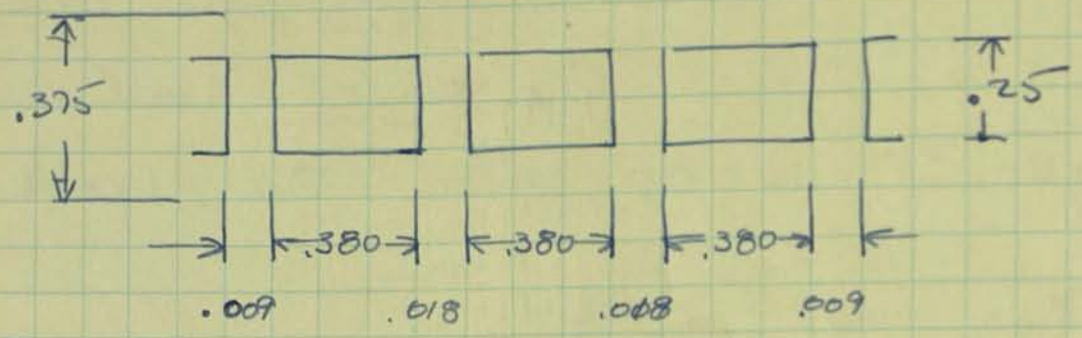
$$n_2^2 = \frac{.0163}{.0034} = 4.8$$

$n_2 = 2.2$ $\simeq$ $\underline{2\frac{1}{4}}$ TURNS.

CONT. FROM p. 67

6/24/63

CONSIDER USING CONSTANT K DESIGN WITH END MATCHING SECTIONS:



DIMENSIONS USED WITH TEFLON DIELECTRIC.

CONSIDER X BAND SOURCE: OUTPUT FREQ.
(9335 - 9415 mc)
60 mc IF

COULD START AT C BAND AND DOUBLE:-

4667.5 - 4707.5 mc

AT BEST ONE MIGHT EXPECT **25%** CONVERSION EFFICIENCY. IF THE C BAND SOURCE PUT OUT SAY 40 mw, THEN 10 mw OUT AT X BAND WOULD BE FEASIBLE.

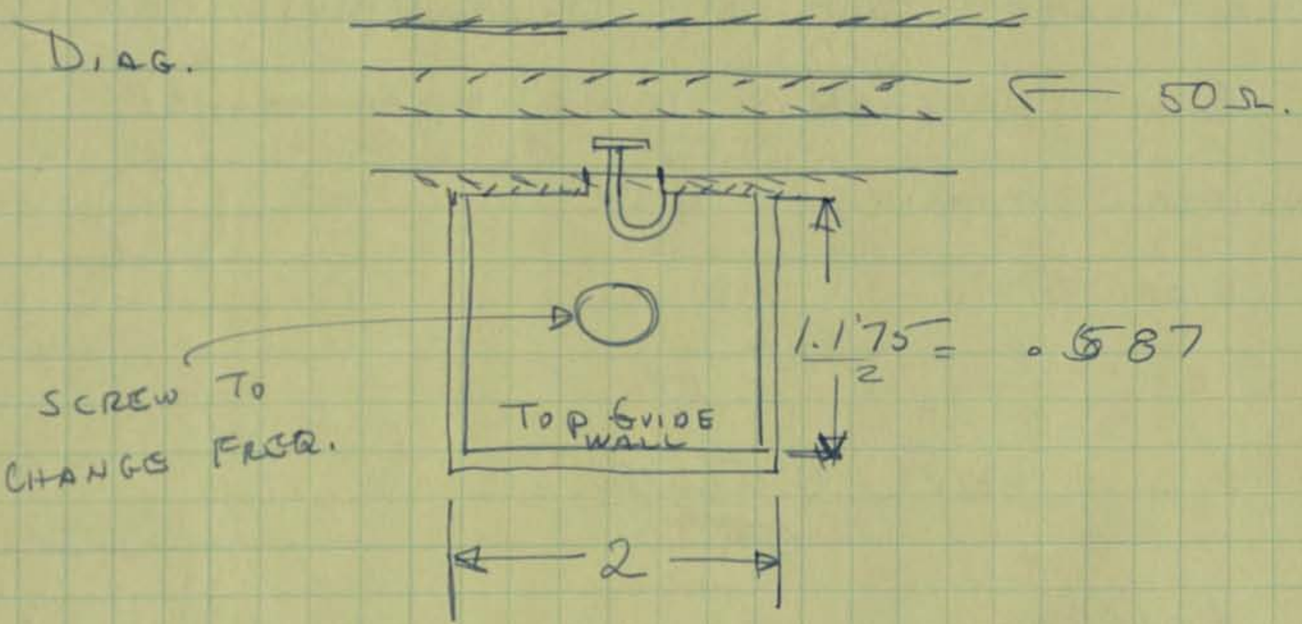
NARROW STOPBAND FILTER 6/27/63
TO BE USED WITH SPECTRUM ANALYSER

WILL USE COAX MAIN LINE TO PASS DOWN TO D.C. A TUNEABLE STUB IN WAVEGUIDE WHICH WILL BE COUPLED IN SHUNT TO COAX WILL PROVIDE SHORT A SINGLE FREQ.

~~SH~~ WAVELENGTH AT HIGHEST FREQ.:

$f = 6.0$ Kmc. $\lambda_g = 1.1753$

DIAG.



WOULD MAKE MORE SENSE TO USE 1.5X.75 GUIDE IN WHICH CASE:

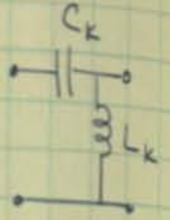
At $f = 6.0$ Kmc. $\lambda = 2.82''$

$\left\{ \frac{\lambda}{2} = 1.42'' \right.$

70 HIGH PASS FILTER 6/27/63

FOR CONSTANT K SECTIONS SUCH AS p. 63

TRY $f_c = 850$ mc. , $R = 50\Omega$



$$C_k = \frac{1}{2\pi f_c R} = \frac{1}{2\pi \cdot .85 \times 10^9 \; 50}$$

$C_k = 3.75$ pf.

$L_k = R^2 C_k = 2500 \cdot 3.75 \times 10^{-12}$

$\frac{10^{-11}}{3} \doteq 3\times10^{-12}$

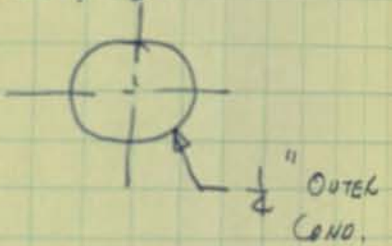
$L_k = 9.37$ nh

TO CALCULATE PHYSICAL DIMENSIONS OF C_k IN COAX PACKAGE. (USING MYLAR TAPE)

$\epsilon_r = 2.9$

CONSIDER CAPACITIVE DISK

.156 OR $\frac{5}{32}$ DIA.



$$C = \frac{.225 \; \epsilon_r \; \pi r^2}{t} \text{ pf.}$$

$$t = \frac{(.225)(2.9)\pi(.078)^2}{3.75 \cancel{\times 10^{-12}}}$$

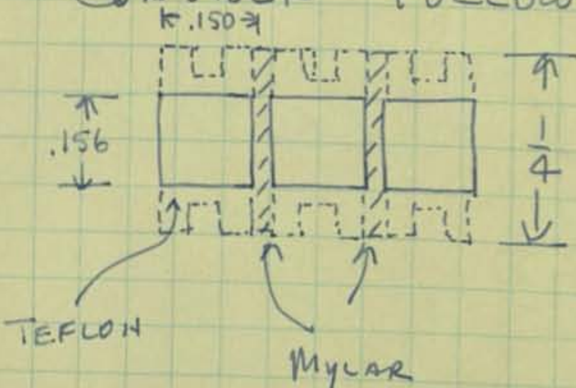
$\frac{(.2)(3)(3)(\overset{.02}{\cancel{.08}}00)}{4}$

.06
.06

.0032

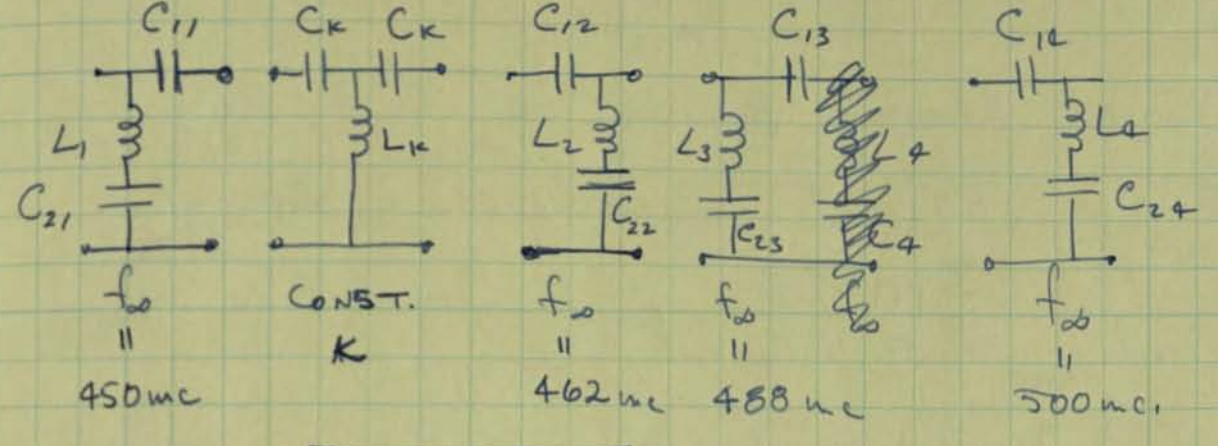
$t = .00425$

CONSIDER FOLLOWING CONSTRUCTION:



HIGH PASS FILTER 6/28/63

CONSIDER DESIGN WITH A FOUR RESONATOR CONSTRUCTION TO GO ALONG WITH 1 CONSTANT - SECTION.



$L_K = 9.37$

$C_K = 3.75p$

$$m = \sqrt{1-\left(\frac{f_\infty}{f_c}\right)^2}$$

$$m_1 = \sqrt{1-\left(\frac{450}{850}\right)^2} = \sqrt{.720} = .850$$

$$m_2 = \sqrt{1-\left(\frac{462}{850}\right)^2} = \sqrt{.704} = .840$$

$$m_3 = \sqrt{1-\left(\frac{488}{850}\right)^2} = \sqrt{.670} = .820$$

$$m_4 = \sqrt{1-\left(\frac{500}{850}\right)^2} = \sqrt{.654} = .810$$

1.0
.2
.7

1.00
.29
.70

1.00
.330
.670

1.00
.346
.654

1.0
.6
.3

TRY $m = \underline{\underline{.83}}$. , $\frac{m}{1-m^2} = \frac{.83}{.320} = \underline{\underline{2.59}}$

$$L_1 = L_2 = L_3 = L_4 = \frac{L_K}{m} = \frac{9.37}{.83} = \underline{11.3\ nh}$$

$$C_{11} = C_{12} = C_{13} = C_{14} = \frac{C_K}{m} = \frac{3.75}{.83} = \underline{4.52}\ pf.$$

$$C_{21} = C_{22} = C_{23} = C_{24} = \frac{m}{1-m^2}\,C_K = (2.59)(3.75) = \underline{9.7}\,pf.$$

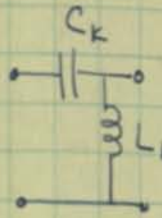
$$\frac{C_{11} \cdot C_K}{C_{11}+C_K} = \frac{(4.52)(3.75)}{8.27} = \underline{2.05}\,pf. = \frac{C_{12}\,C_K}{C_{12}+C_K}$$

$$\frac{C_{13}\ C_{14}}{C_{13}+C_{14}} = \frac{4.52}{2} = \underline{2.26}\,pf.$$

HIGH PASS FILTER

6/27/63

FOR CONSTANT K SECTIONS SUCH AS p. 63



TRY $f_c = 850$ mc. , $R = 50\Omega$

$$C_K = \frac{1}{2\pi f_c R} = \frac{1}{2\pi \cdot .85 \times 10^9\ 50}$$

$$\underbrace{C_K = 3.75}\ pf.$$

$$L_K = R^2 C_K = 2500 \cdot 3.75 \times 10^{-12}$$

$$\frac{10^{-11}}{3} \approx 3 \times 10^{-12}$$

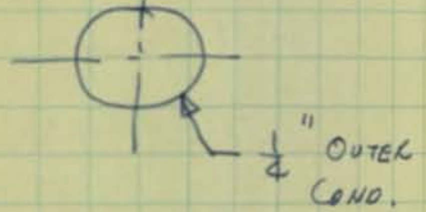
$$\underbrace{L_K = 9.37\ nh}$$

TO CALCULATE PHYSICAL DIMENSIONS OF C_K IN COAX PACKAGE. (USING MYLAR TAPE)

$\epsilon_r = 2.9$

CONSIDER CAPACITIVE DISK

.156 OR $\frac{5}{32}$ DIA.



$$C = \frac{.225\ \epsilon_r\ \pi r^2}{t}\ pf.$$

$$t = \frac{(.225)(2.9)\pi(.078)^2}{3.75\ \cancel{\times 10^{-12}}}$$

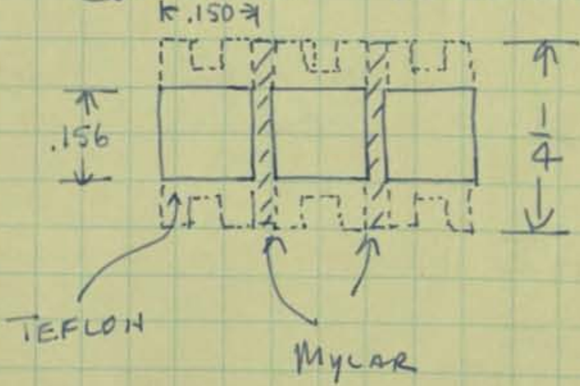
$$\frac{(.2)(3)(3)(\overset{.02}{\cancel{.08}})(.00)}{4}$$

.08
.04

.0032

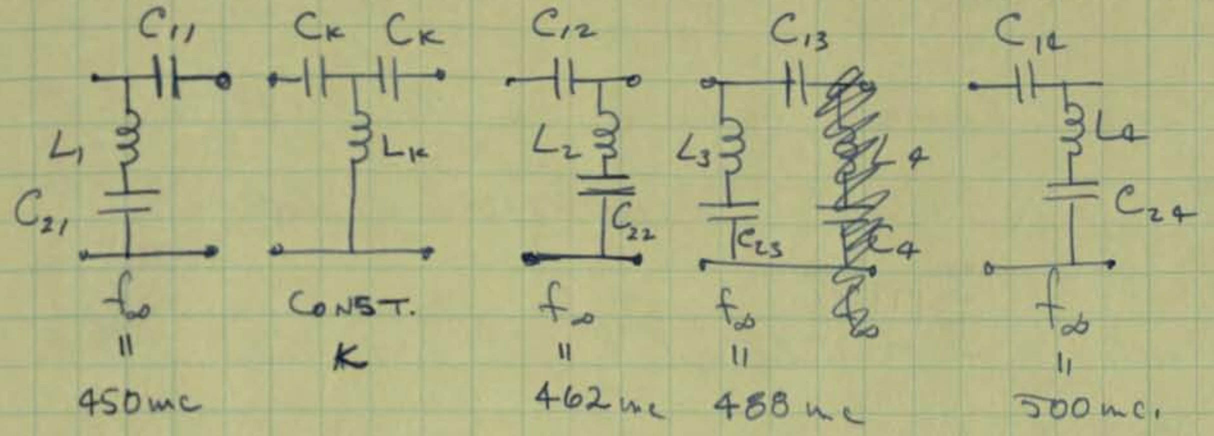
$$\underbrace{t = .00425}$$

CONSIDER FOLLOWING CONSTRUCTION:



HIGH PASS FILTER 6/28/63

CONSIDER DESIGN WITH A FOUR RESONATOR CONSTRUCTION TO GO ALONG WITH 1 CONSTANT k SECTION.



$L_k = 9.37\,nh$

$C_k = 3.15\,pf.$

$$m = \sqrt{1-\left(\frac{f_\infty}{f_c}\right)^2}$$

$$m_1 = \sqrt{1-\left(\frac{450}{850}\right)^2} = \sqrt{.720} = .850$$

1.000
.280
.720

$$m_2 = \sqrt{1-\left(\frac{462}{850}\right)^2} = \sqrt{.704} = .840$$

1.000
.296
.704

$$m_3 = \sqrt{1-\left(\frac{488}{850}\right)^2} = \sqrt{.670} = .820$$

1.000
.330
.670

$$m_4 = \sqrt{1-\left(\frac{500}{850}\right)^2} = \sqrt{.654} = .810$$

1.000
.346
.654

TRY $m = \underline{\underline{.83}}$, $\frac{m}{1-m^2} = \frac{.83}{.320} = \underline{\underline{2.59}}$

1.000
.680
.320

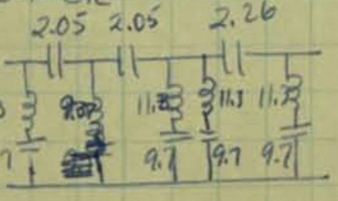
$$L_1 = L_2 = L_3 = L_4 = \frac{L_K}{m} = \frac{9.37}{.83} = \underline{11.3\ nh}$$

$$C_{11} = C_{12} = C_{13} = C_{14} = \frac{C_K}{m} = \frac{3.75}{.83} = \underline{4.52}\ pf.$$

$$C_{21} = C_{22} = C_{23} = C_{24} = \frac{m}{1-m^2}\,C_K = (2.59)(3.75) = \underline{9.7}\,pf.$$

$$\frac{C_{11}\cdot C_K}{C_{11}+C_K} = \frac{(4.52)(3.75)}{8.27} = \underline{2.05}\,pf = \frac{C_{12}\,C_K}{C_{12}+C_K}$$

$$\frac{C_{13}\,C_{14}}{C_{13}+C_{14}} = \frac{4.52}{2} = \underline{2.26}\,pf.$$



CONT. FROM p. 71 7/1/63

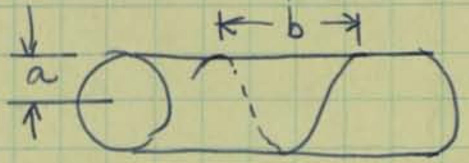
PHYSICAL DIMENSIONS OF $L = 11.3$ nh

USING EXPRESSION $L = \frac{Z_0}{v_p}$ HENRIES/m.

SINGLE LINE ABOVE GROUND $\cong$ $Z_0 = 180\Omega$.

$L = \frac{180}{3\times10^8} = 60\times10^{-8} = 600\times10^{-9} = 600$ nh/m.

$L = 6$ nh/cm. $= 15.2$ nh/inch



$s = \sqrt{(2\pi a)^2 + b^2}$

LET $2a = .2$

$2\pi a = .628$, $(2\pi a)^2 = .395$

553
.395
.158

$b^2 = S^2 - .395$

IF $S = \cancel{15.2}\ \frac{11.3}{15.2} \cong .744''$, $S^2 = .553$

$b^2 = .158$, $b = .399 \cong .4''$

OR $\underbrace{2 \text{ TURNS IN } .2''}$

Now FOR $L = 9.37$ nh.

$S = \frac{9.37}{15.2} = \underbrace{.616''}$ ~~S²a .38~~

TO GROUND.

FOR CAPACITIES: (USING MYLAR $\varepsilon_r = 2.9$)

$C = 2.05$ pf.

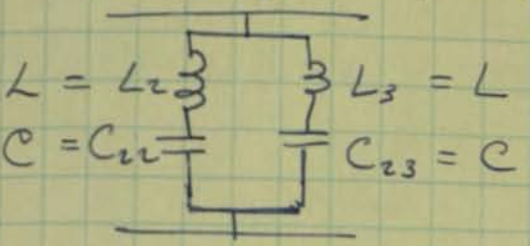
$t = \frac{(.225)(2.9)\,\pi\left(\frac{.156}{2}\right)^2}{2.05} = \underbrace{.0061}$

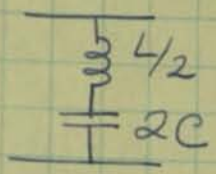
$C = 2.26$

$t = .0061\ \frac{2.05}{2.26} = \underbrace{.0055}$

CONT. FROM p. 72 7/1/63

CONSIDER COMBINING THE SERIES TANKS $L_2 - C_{22}$ AND $L_3 - C_{23}$ ON p. 71.



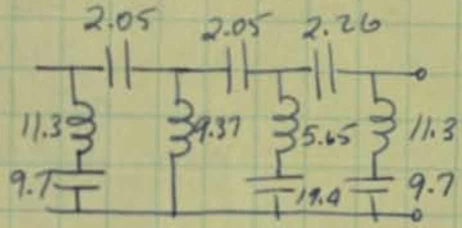


$$\frac{j(\omega L-\frac{1}{\omega C})\cancel{j(\omega L-\frac{1}{\omega C})}}{2\cancel{j}\cancel{(\omega L-\frac{1}{\omega C})}}$$

$$j\left(\omega\frac{L}{2}-\frac{1}{\omega 2C}\right)$$

$\frac{L}{2} = \frac{11.3}{2} = 5.65$ nh.

$2C = (2)(9.7) = 19.4$ pf



PHYSICAL DIMENSIONS OF L = 5.65 nh

SHOULD BE 1 TURN IN .2

PHYSICAL DIMENSIONS OF C = 19.4 pf $\varepsilon_r = 2.9$
USING CYLINDRICAL SHAPE.

$\pi D l = A$ $A = \frac{c\,t}{\varepsilon_r\ .0225} = \frac{(19.4)\ .005}{(2.9)\ (.225)}$

LET $D = .375$ $A = .149$

$l = \frac{.149}{(3.14)(.375)} = .126$ ← 2 LAYERS OF $2\frac{1}{2}$ MILL MYLAR.

IF $D = .125$

$l = .126\ \frac{.375}{.125} = .378$

7/3/63 CONT. FROM p 73

CONSIDER PHYSICAL DIMENSIONS OF COILS USING TERMAN.

FOR $L = 11.3$ nh. $F = .017$ $d = .2$

$$n^2 = \frac{L_0}{F d} = \frac{11.3 \times 10^{-3}}{(.017)(.2)} = 3.32$$

$$\underbrace{n = 1.82}$$

IF $\left\{ \begin{matrix} d = .125 \\ l = .2 \end{matrix} \right\} \frac{d}{l} = .625$

$\therefore F = .012$

FOR $L = 11.3$ nh

$$n^2 = \frac{.0113}{(.012)(.125)} = 7.54$$

$$\underbrace{n = 2\,3/4}$$

FOR $L = 9.3$ nh

$n^2 = 6.2$

$$\underbrace{n = 2\,1/2}$$

FOR $L = 5.65$ nh

$n^2 = 3.77$

$$\underbrace{n = 1.95 \approx 2}$$

FOR $L = 9.3$ nh.

$$n^2 = \frac{.0093}{(.017)(.2)} = 2.74$$

$$\underbrace{n = 1.66}$$

FOR $L = 5.65$ nh

$n^2 = 1.76$

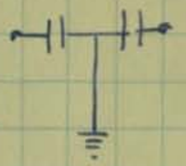
$$\underbrace{n = 1.33}$$

EXPERIMENTAL DATA

f. (mc)	I.L. db	f. (mc)	I.L. db
1000	1.5		
950	1.6	600	21.0
900	2.4	550	33.5
850	5.8		
800	11.0		
750	16.4		
700	26.5		
670	29.0		
650	24.5		

16/8/63 CONT. FROM p. 74

CONSIDER HIGH PASS FILTER USING HELICAL LINE. 1080 - 1180



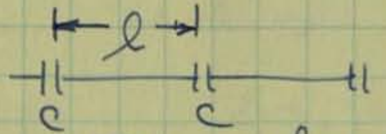
WITH $R = 50\Omega$

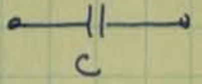
AND POSSIBLY $Z_1 = 200\Omega$.

$\tan\theta_0 = \frac{\cancel{Z_1}\,R}{\cancel{R}\,Z_1} = \cancel{4}.25$, $\theta_0 = \cancel{4.04}\ 76^\circ$

$\frac{f_2}{f_1} \simeq 1.4$ { IF $f_1 = 1000$ mc $f_2 = 1400$
OR $f_1 = 900$ mc $f_2 = 1260$

CONSIDER ANOTHER TYPE.





WITH $Z_1 = 200\Omega$. , $R = 50$.

$\frac{Z_1}{R} = 4 = \tan\frac{\theta_0}{2}$, $\frac{\theta_0}{2} = 76^\circ$, $\theta_0 = 152^\circ$

AGAIN $\frac{f_2}{f_1} \simeq 1.4$

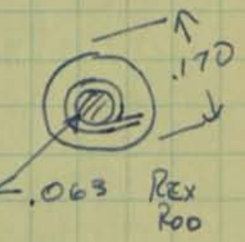
THIS MEANS RESONATOR l IS $\lambda/2$ AT 1.4 kmc

OR $\frac{\lambda}{4}$ AT 2.8 kmc.

FROM CHART :-
MAC ALPINE - SCHILDKNECHT

SHIELD DIA. = .170
INCHES/TURN $\simeq$ .040

CONSIDER .020 WIRE # ~~E~~ 24
ALSO GIVES 4 TURNS.



TO CALCULATE C :

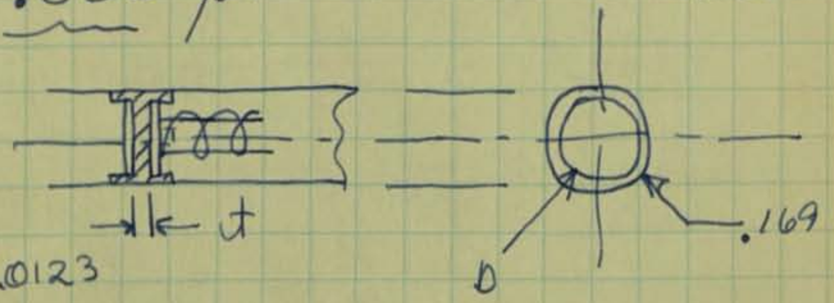
$$C = \frac{\cot 90^\circ \frac{f_1}{f_2}}{2\pi f_1 Z_1} = \frac{\cot 64.3}{2\pi\ 10^9\ 200}$$

$$= \frac{.481 \times 10^{-9}}{400\pi} = .383\ pf.$$

$$\begin{array}{r} .063 \\ .020 \\ \hline .083 \end{array}$$

USING TEFLON

$$t = \frac{(.225)(2.1)\,A}{C}$$

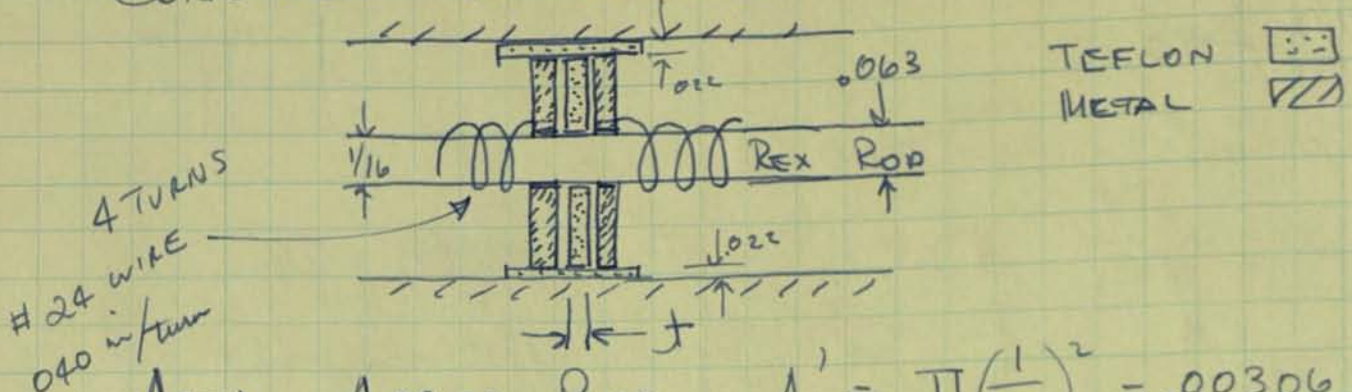


TRY $D = .125$, $A = \pi\left(\frac{1}{16}\right)^2 = .0123$

$$t = \frac{(.225)(2.1)(.0123)}{.383} \simeq .015$$

CONT. FROM p. 75 7 8/8/63

CONSIDER ALTENATE CONSTRUCTION.



.169
.125
2⟌.044
.022

$\frac{1}{30 \cdot 30} = \frac{1}{300}$

AREA ACROSS ROD $A' = \pi\left(\frac{1}{32}\right)^2 = .00306$

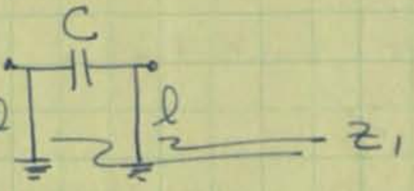
∴ NET AREA = .0123 − .0031 = .0092

.0123
.0031
.0092

$\therefore f = .0152 \quad \cancel{\frac{.0123}{.0092}} \; \frac{.0092}{.0123} = \underset{\sim\sim}{.0114}$

ABOVE DESIGN NOT CORRECT — WOULD REQUIRE 4 TIMES THE TURNS —

GOING BACK TO —



AGAIN $R = 50\,\Omega$. THIS TIME $Z_1 = 100\,\Omega$.

$\tan\theta_0 = \frac{R}{Z_1} = .5$, $\theta_0 =$ ~~60°~~ 26.5

$\therefore \frac{f_2}{f_1} \simeq 5$

IF $Z_1 = 150\,\Omega$.

$\tan\theta_0 = .33$, $\theta_0 = 18.4°$

IF $Z_1 = 130\,\Omega$, $\tan\theta_0 = \frac{50}{130} = .385$

$\frac{f_2}{f_1} \simeq 6.0$

$\theta_0 = 21° = .366$ rad.

$C = \frac{l}{Rc\theta_0} = \frac{1.25}{(50)(3\times10^{10})(.366)}$

$l = \frac{\lambda}{4} = \frac{3\times10^{10}}{(4)\;6\times10^{9}} = \frac{30}{24} = 1.25$cm

@ 6 kmc

$C \simeq 2.3$ pf.

CONT. FROM p. 76 7~~3~~/9/63

FROM SCHILDKNECHT & MACALPINE

$2\frac{1}{2}$ TURNS & ABOUT .040"/TURN. ~~OF~~ WITH $\frac{1}{16}$ DIA.

TRY $Z_1 = 120\,\Omega$ $\tan\Theta_0 = \frac{50}{120} = .416$, $\Theta_0 = 22.6$

$\frac{f_2}{f_1} = 5.5$, $f_2 = 5.5$ kmc $= .394$ rad.

$2\frac{1}{4}$ TURNS & ABOUT .055"/TURN ON $\frac{1}{16}$ DIA. ROD

SHIELD DIA. BECOMES .150 – TRY .156 ~ $\frac{5}{32}$ BALL END MILL

$$l = \frac{\lambda_2}{4} \doteq \frac{3\times10^{10}}{(4)\;5.5\times10^9} = 1.36 \text{ cm.}$$

$$C = \frac{1.36}{(50)(3\times10^{10})(.394)} = \underset{\sim}{2.3\,pf.}$$

TO OBTAIN PHYSICAL DIMENSIONS OF C USING MYLAR $\epsilon_r = 2.9$

AND THICKNESS OF 2.5×10^{-3} INCHES

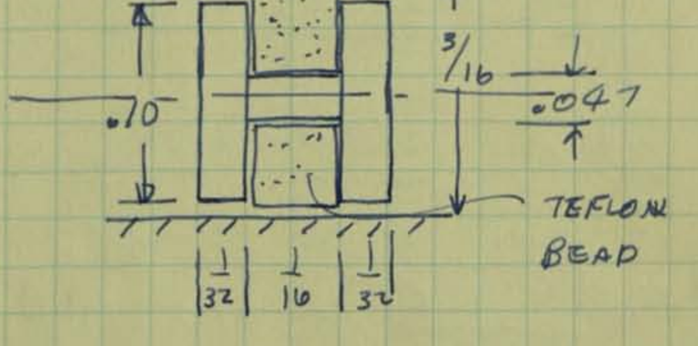
$$A = \frac{C\,t}{(.225)(\epsilon_r)} = \frac{(2.3)(2.5\times10^{-3})}{(.225)(2.9)} = .0088$$

$$A = \pi r^2 = .0088,\quad r^2 = .0028$$

$$r = .053 \text{ or } d = .106$$

CONSIDER 3/16 DIA FOR STRAIGHT THRU CONDUCTOR

50Ω LINE IN TEFLON



$$Z_0 = \frac{138}{\sqrt{\epsilon_r}} \log\frac{D}{d}$$

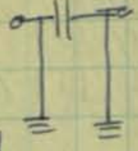
$$\log\frac{.156}{d} = .525$$

$$\frac{.156}{d} = 3.34$$

$$d = .047$$

7/15/63 HIGH PASS FILTER

$f_c = 0.9$ kmc. $R = 30\Omega$.



TRY $f_2 = 5.0$ kmc.

$f_2/f_1 = 5.5$, $\theta_0 \overset{\sim}{=} 23° = .4$ rad.

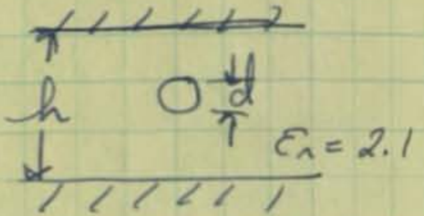
$\tan\theta_0 = .425$, $Z_1 = \frac{R}{\tan\theta_0} = \frac{30}{.425} \overset{\sim}{=} 71\Omega$

IF. $R = 40\Omega$.

$$Z_1 = \frac{40}{.425} = 94\Omega.$$

SMALLEST WIRE - #32 - ~ .008" IN DIA.

FOR

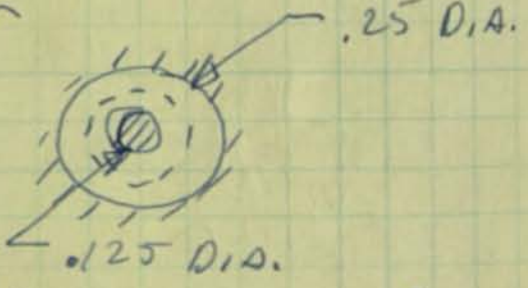


$$\log\frac{4h}{\pi d} = \frac{Z_1\sqrt{\epsilon_r}}{138} = \frac{(94)(1.45)}{138}$$

$$\log\frac{4h}{\pi d} = .99 , \frac{4h}{\pi d} = 9.75$$

$$h = \frac{9.75\ \pi\ .008}{4} = .061$$

PUT ON CYLINDRICAL FORM



$$C = \frac{l}{Rc\theta_0}$$

$$C = \frac{1.03}{(30)\,3\times10^{10}(.4)} \overset{\sim}{=} \overset{2.86}{\cancel{1.15}}\ pf.$$

$$l = \frac{\lambda_2}{4} = \frac{1}{4_{(1.45)}}\frac{3\times10^{10}}{5\times10^9} = \frac{1.5\text{ cm}}{1.45}$$

$$l = 1.03\text{ cm} = .41\text{ in.}$$

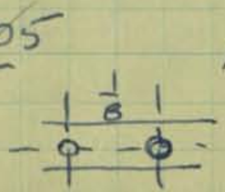
$$C = \frac{.225\,\epsilon_r\,\pi\,r^2}{t}$$

$$t = \frac{.225\,\epsilon_r\,\pi\,r^2}{C} = \frac{(.225)(2.1)\,\pi\,(.062)^2}{1.15}\ \frac{1.15}{2.86} \overset{\sim}{=} .002$$

$t = .005$, $\pi d = (3.14)(.125) = .392$

or

$(3.14)(.187) = .590$



7/16/63

HIGH PASS FILTER
(CONT.)

START WITH $t = .005$ OF TEFLON

$$A = \frac{Ct}{.225\,\varepsilon_r} = \frac{(2.86)(.005)}{.225\ \ 2.01} = .0302 = \pi r^2$$

$r^2 = .00963$, $\underline{r = .098}$ $d = .196$

.250
.196
2).054
.027

USING MYLAR WITH $\frac{1}{8}$ DIA. ROD.

$t = .002$ $\frac{2.9}{2.1} =$ ~~2.76~~ $\underline{.00276}$

CONSIDER CYLINDRICAL CAPACITOR
.095 ~~.030~~ DIA.

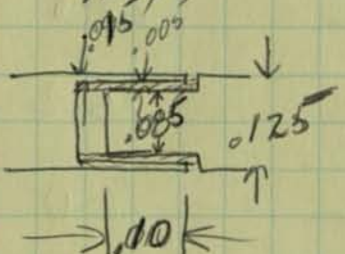
USING $t = .005$

.125
.030
.095

$$A = \pi d l = .0302$$

$$l = \frac{.0302}{(3.14)(\cancel{.0330})\ .095} \cong \cancel{.010}\ .132$$

Ø.10



.125
.040
.085

INSERTION LOSS VS. FREQ.

FREQ. (mc)	I. L. (db)	FREQ. (kmc)	I. L. (db)
800 mc.	43	2.0	12.0
900 mc.	23		
~~950~~ 950	6.6		
1000	2.5		
1100	1.4		
1200	1.4		
1300	.65		
1500	2.30		

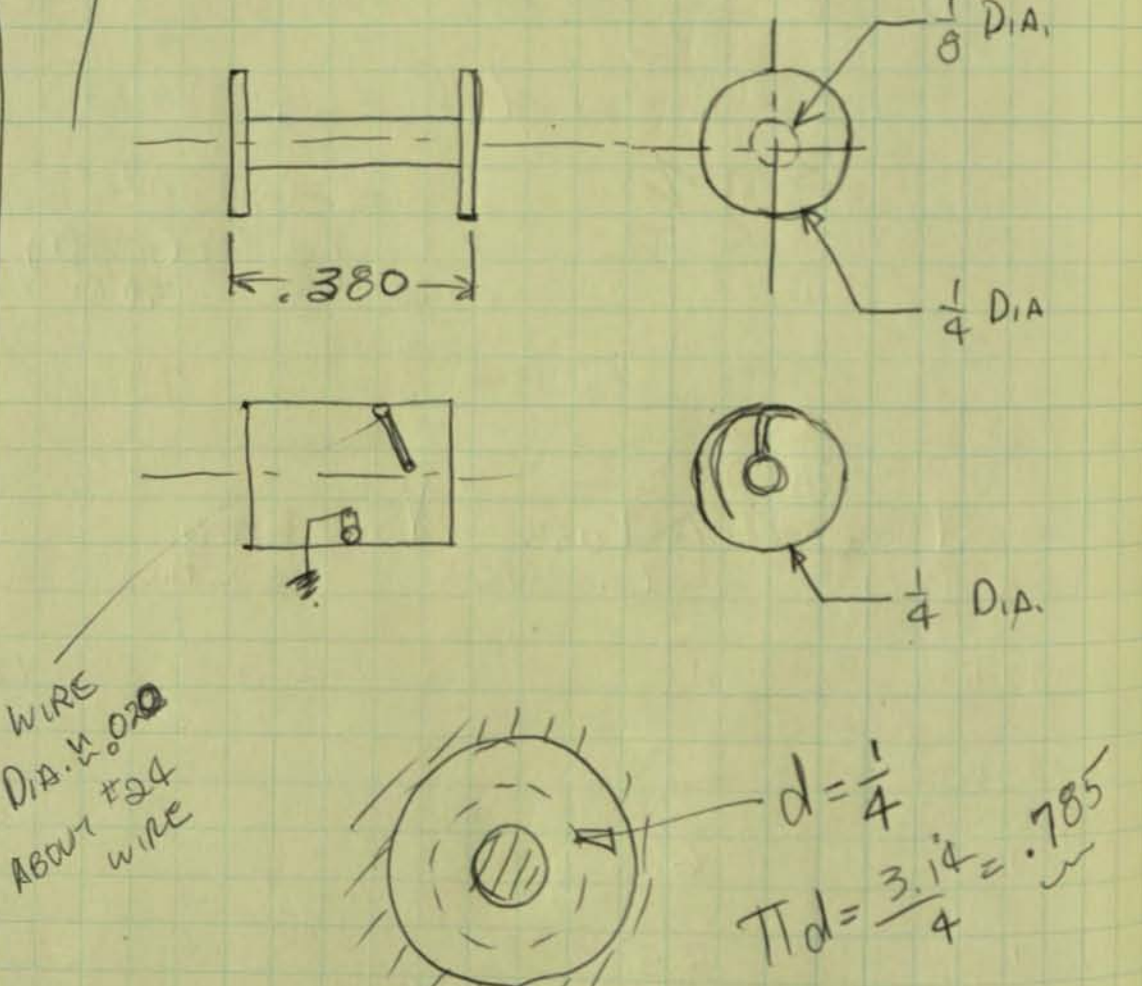
7/18/63 H.P. FILTER

.10 overlap on ends

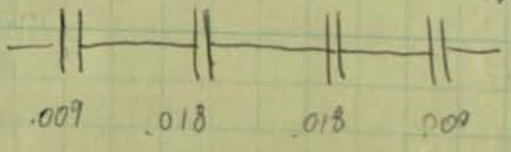
.005 DISCS IN CENTER SECTIONS

FREQ (Kmc)	I.L. (db)		.085 spacing on end C's	FREQ (Kmc)	I.L. (Db)
.800	~~[illegible]~~	18.5	22.0	6.0	6.7
.850	4.3		6.1		
.900	2.3		3.1	6.0	.3
1.000	1.3		1.0	2.0	
1.100	1.2		1.35	1.75	
1.150	.8		1.05	1.80	
1.200	.6		.65	1.25	
1.300	2.2		1.60		
1.400	1.8		2.00		
1.600	1.0				
1.800	6.2				
2000	10.0				
2.2	17.0				
2.4	15.2				
2.6	16.0				
2.8	18.3				
3.0					
3.2	18.2				
3.4					
3.6	17.3				
3.8					
4.0	15.0				
4.4	11.8				
4.8	7.7				

HIGH PASS CONSTRUCTION



SPACING ~~BE~~ FOR CAPACITORS IN TEFLON



7/19/63 CONT. FROM p. 80

C FOR A .009 SPACER

$$C = \frac{(.225)(2.1)\pi(.125)^2}{.009} = \underline{2.58\,pf.}$$

$\ell \simeq .8'' = \frac{\lambda_2}{4}$ IN TEFLON

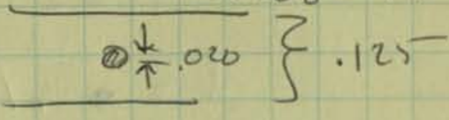
$\lambda_2 = 3.2'' = $

$$\therefore f_2 = \frac{3\times10^{10}}{3.2\times2.54\times1.45} = 2.54\ \text{Kmc.},\quad \frac{f_2}{f_1} = \frac{2.54}{.7} = 3.63$$

$\theta_0 = 35°$

$\tan\theta_0 = .7$

Z_0 OF LINE TO GROUND



$\frac{.020}{.125} = .16 \quad \therefore \sqrt{\varepsilon_r}\, Z_0 = 125\Omega$

$$Z_0 = \frac{125}{1.45} = \underline{86.2}$$

$$\therefore R = Z_1 \tan\theta_0 = (\overset{125.}{86.2})(.7) \overset{\sim}{=} \overset{87.5}{60}\Omega.$$

USING 60Ω ON DESIGN p. 78

$$C = \frac{1.03}{(60)(3\times10^{10})(.4)} = 1.43\,pf.$$

$t = .004$

& ~~$Z_1 = 60 \tan\theta_0 = 60°$~~

$$Z_1 = \frac{R}{\tan\theta_0} = \frac{60}{.425} = 141\Omega.$$

$Z_1\sqrt{\varepsilon_r} = 205\Omega$

$\frac{D}{b} = .05$, w/ $D = .008$

$b = \frac{.008}{.05} = .160$

CONSIDER USING $\theta_0 = 35°$, $f_2 = 3.6$ Kmc, $\ell = \frac{1}{4}\frac{3\times10^{10}}{3.6\times10^{9}} = 2.08''$ a

$= .82''$ in air

or $\frac{.82}{1.45} = .565''$ in tefl

$= .61$ radians

$$C = \frac{2.08}{(\overset{}{\underset{81.5}{60}})\, 3\times10^{10}\, .61} = \underset{1.3\,pf.}{1.9\,pf.},\quad \frac{C}{2} = \underset{.65}{.95\,pf.}$$

& $\ell = .565''$

CONT. FROM p. 81

PHYSICAL DIMENSIONS OF CAPACITORS

USING .25 DISC. & TEFLON

$$t = \frac{(.225)(2.1)\pi(.125)^2}{1.9} = .0122$$

START WITH $t = .005$

$$r^2 = \frac{(.005)(1.9)}{(.225)(2.1)\pi} = .0064, \quad r = .080$$

$d = \underline{.160}$

USING $D = .375$

GIVES GROUND PLANE

SPACING OF $b = .108$

TO MAINTAIN $\sqrt{\epsilon_r} Z_0$ OF 125Ω.

WITH $\frac{D}{b} = .16$

$D = (.108)(.16) = .0173$

#26 WIRE

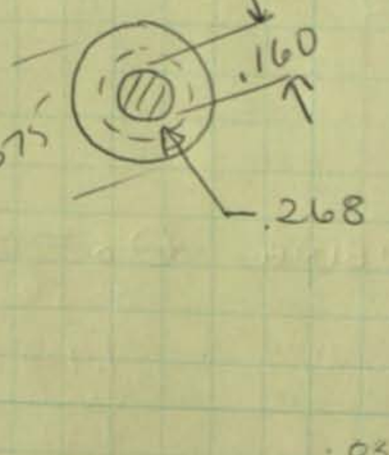
$$\begin{array}{r} 3 \\ .375 \\ .160 \\ \hline 2\,\big)\,.215 \\ \hline .1075 \end{array}$$

$$t = \frac{(.225)(2.1)\pi(.0064)}{1.3} = \underline{.0073}$$

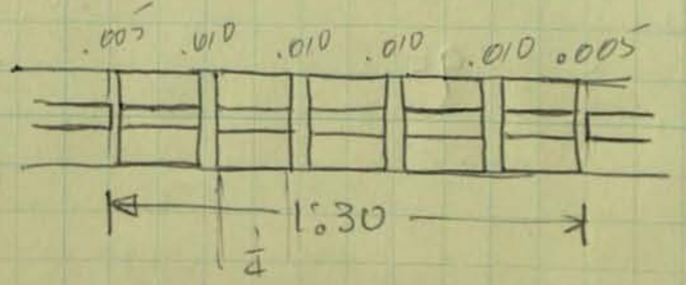
WIRE LOOP DIA.

$\pi\ .268 = \underline{.840}$

$$\begin{array}{r} .160 \\ .108 \\ \hline .268 \end{array}$$



DIAG. OF FILTER



$\frac{.375}{2.3} =$

.030
.25

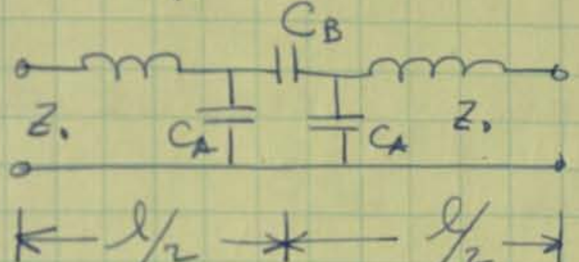
9/16/63

INPUT BANDPASS FILTER FOR [illegible] 2.1 - 2.4 Kmc

OUTPUT FREQ. DOUBLER - OSCILLATOR

FREQUENCY - 1.05 - 1.2 Kmc

FILTER TYPE:



$f_1 = 1.00$ kmc $\quad f_2 = 1.25$ kmc

$\frac{f_1}{f_2} = .8 \,, \quad \left(\frac{f_1}{f_2}\right)^2 = .64$

$1 - \left(\frac{f_1}{f_2}\right)^2 = .36$

SELECT $\Theta_2 = .5$ RADIAN $\quad \Theta_1 = .4$ RADIAN

ALSO $Z_0 = 188\,\Omega$

$$C_A = \frac{1}{\omega_1 \Theta_2 Z_0} \frac{f_1}{f_2} = \frac{1}{(2\pi \times 10^9)(.5)\,188 \quad 1.25}$$

$\frac{1}{3 \cdot .2 \cdot 1} = \frac{1}{.6}$

$C_A = 1.36$ pf.

$$C_B = \frac{1}{2\omega_1 \Theta_1 Z_0}\left[1 - \left(\frac{f_1}{f_2}\right)^2\right] = \frac{.36}{2(2\pi \times 10^9)(.4)\,188}$$

$C_B = .381$ pf. , $2\,C_B = .76$ pf.

$\frac{1}{4 \cdot 3 \cdot .2} = \frac{1}{2.4}$

$$Z_{I0} = \frac{Z_0\left[\frac{f_2}{f_1} - 1\right]}{\sqrt{\left(\frac{f_2}{f_1}\right)^2 + 1 + \Theta_2^2 + \frac{1}{\Theta_1^2}}} = \frac{(188)(.25)}{\sqrt{(1.25)^2 + 1 + .25 + \frac{1}{.16}}}$$

$$= \frac{47}{3.01} = 15.6\,\Omega$$

$$\begin{array}{r} 1.56 \\ 1.25 \\ 6.25 \\ \hline 9.06 \end{array}$$

$\beta_1 \ell/2 = .4 \,, \quad \ell/2 = \frac{.4}{\beta_1} = \frac{.4}{2\pi}\lambda_1$

$\lambda_1 = 30$ cm.

$\ell/2 = \frac{.4}{2\pi}\,30 = 1.91$ cm

10/1/63 CONT. FROM p. 83

$\theta_1 = .4$ RAD. ~ $f_1 = 1.0$ KMC.
$\theta_1 = 23°$

$\theta_2 = .5$ RAD ~ $f_2 = 1.25$ KMC
$\theta_2 = 28.6°$

$\theta_0 = .45$ RAD ~ $f_0 = 1.125$ KMC.
$\theta_0 = 25.8°$

CONSIDER $2C_B = 1.0$ pf. KEEPING EVERYTHING THE SAME – SOLVE FOR Z_0

$$Z_0 = \cancel{\frac{1}{.381}}\ .381 \times \frac{188}{.5} = 143\,\Omega$$

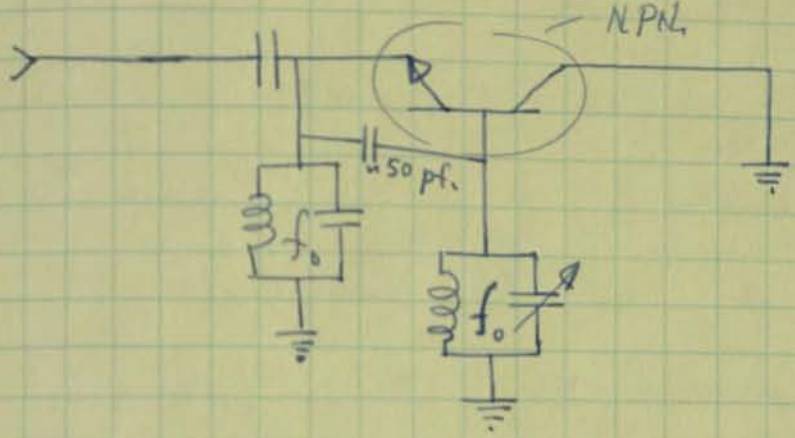
$$\{\ Z_{I0} = \frac{(.25)(143)}{3.01} \overset{\sim}{=} 12\,\Omega$$

TOO LOW!

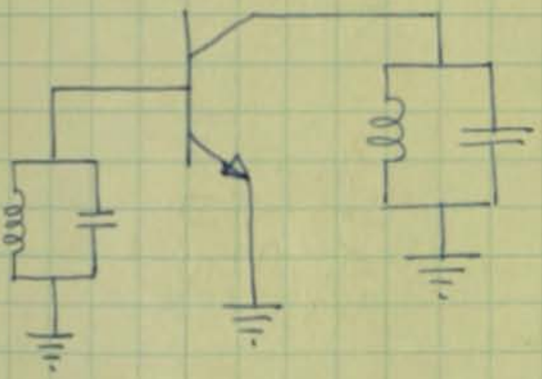
10/3/63

TRANSISTOR OSCILLATOR CIRCUIT.

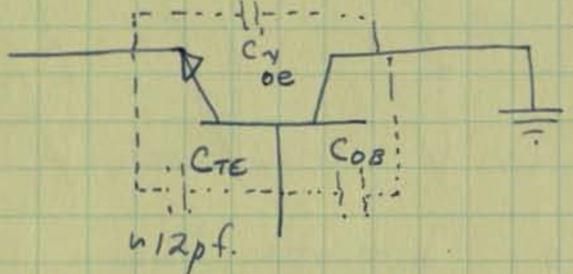
START WITH GROUNDED COLLECTOR COLLPITTS OSCILLATOR:



FROM R. F. STANDPOINT IT IS THE SAME AS:
(GROUNDED EMITTER)

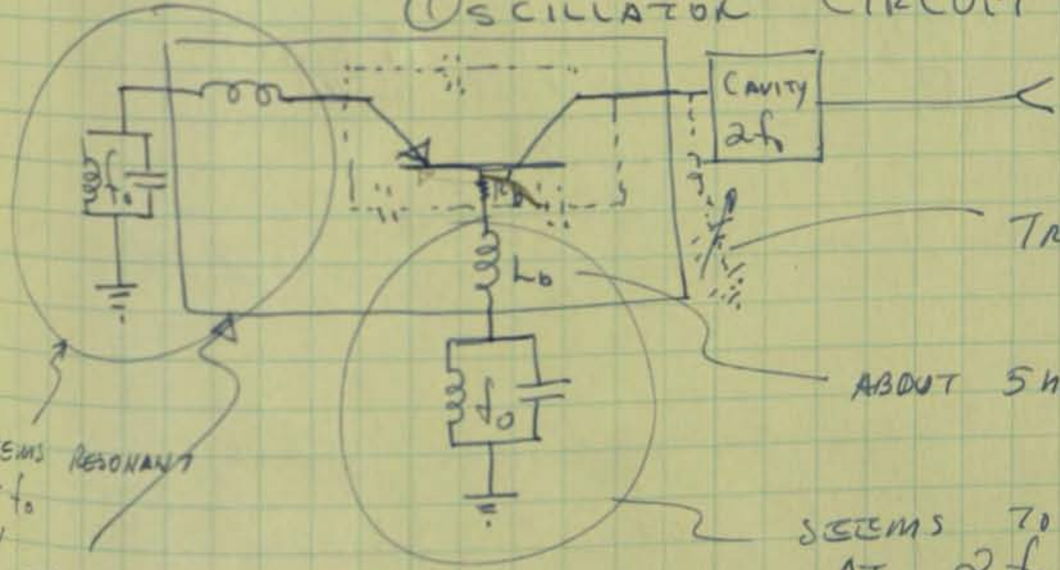


RESIDUAL CAPACITIES:



C_{TE} - TRANSITION CAPACITY

OSCILLATOR CIRCUIT BEING USED



TRAP - IMPROVED EFFICIENCY BUT NARROW BANDED.

ABOUT 5 nh.

SEEMS RESONANT AT f_0

TRANSISTOR

SEEMS TO BE SERIES RESONANT AT $2f_1$

EFFECTS FREQ. MORE THAN BASE CIRCUIT.

10/17/63 BANDPASS FILTER, INPUT

A VARIATION OF PROBLEM ON P. 83

OUTPUT BANDWIDTH 8.5 Kmc. - 9.6 Kmc.

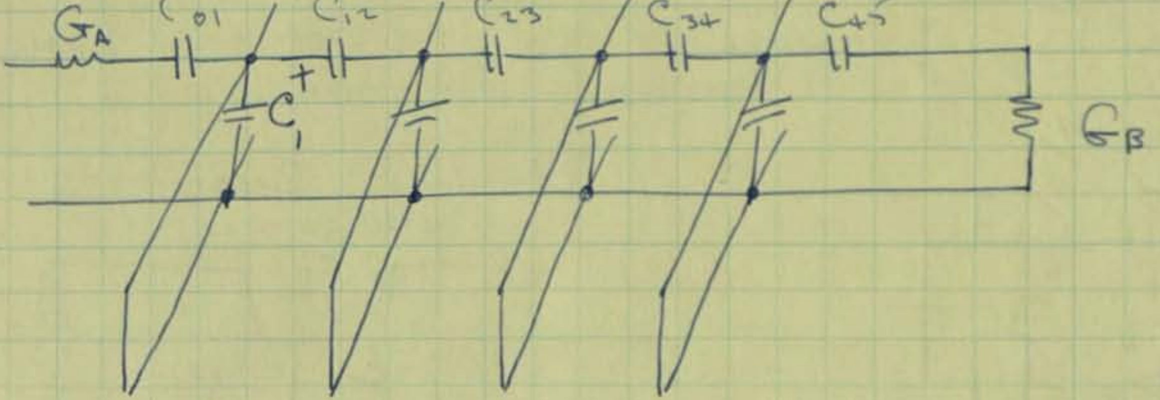
IF WE TRIPLE TWICE

$f_1' = .945$ Kmc. , $f_2' = 1.07$ Kmc.

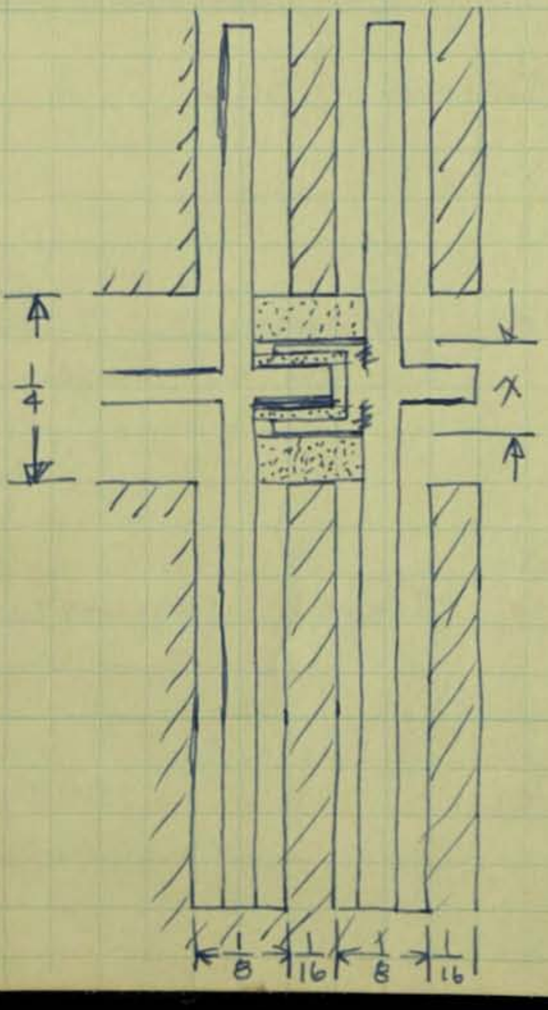
CONSIDER $f_1 = .9$ Kmc. & $f_2 = 1.1$ Kmc.

THIS WOULD GIVE A 20% BANDWIDTH.

CONSIDER THE FOLLOWING FILTER TYPE:-



ALSO CONSIDER THE FOLLOWING CONSTRUCTION:-



Try $x = .125$

$$C_1^+ \cong \frac{(.225)(2.1)(\pi)\ \overset{3/16}{[illegible]}\ 3/16}{.062}$$

$$C_1^+ = \frac{(.225)(2.1)\pi\ 9}{16} = \underline{0.835\ pf.}$$

FOR ESTIMATING PURPOSES

TRY $C_1^+ \cong .8$ pf.

10/18/63 CONT. FROM p. 86

SELECT $n = 4$, .1 db RIPPLE , $\omega_1' = 1$

$g_0 = 1$
$g_1 = 1.1088$
$g_2 = 1.3061$
$g_3 = 1.7703$
$g_4 = .818$
$g_5 = 1.3554$

$$w = 2 \frac{w_2 - w_1}{w_2 + w_1} = 2 \frac{200}{2000}$$

$\underline{w = .20}$ — 20% BANDWIDTH

$$\omega_0 = \frac{2 \omega_2 \omega_1}{\omega_2 + \omega_1} = \frac{2 \cdot 2\pi \quad .9 \cdot 1.1}{2.0} \times 10^9$$

$$W_0 = 1.98\pi \times 10^9 = \underline{6.21 \times 10^9}$$

ALSO $G_A = \frac{1}{25\Omega} = \underline{.04} ℧$, $G_B = \frac{1}{50\Omega} = \underline{.02} ℧$

TRY $Y_0 = \frac{1}{50\Omega} = \underline{.02} ℧$

SINCE DIODE ZERO BIAS CAPACITY IS ABOUT 1.0pf.

LET $C_{01} = 1.0$ pf.

$$B_1^J = \left[\frac{\omega_0 C_{01}}{1 + \left(\frac{\omega_0 C_{01}}{G_A}\right)^2} + \omega_0 C_1^* + \omega_0 C_{12} \right)$$

$$\frac{\omega_0 C_{01}}{G_A} = \frac{1.98\pi \times 10^{-3}}{4 \times 10^{-2}} = 1.555 \times 10^{-1}$$

$$= .1555$$

$$\left(\frac{\omega_0 C_{01}}{G_A}\right)^2 = .0242 , \quad \frac{\omega_0 C_{01}}{1 + \left(\frac{\omega_0 C_{01}}{G_A}\right)^2} = \frac{1.98\pi \times 10^{-3}}{1.0242} = \underline{6.07 \times 10^{-3}}$$

6.07
4.97
4.66
15.70

$\omega_0 C_1^* = \cancel{2\pi} (6.21 \times 10^9)(.8 \times 10^{-12}) = \underline{4.968} \times 10^{-3}$

TRY $C_{12} = .75$ pf. , $\omega_0 C_{12} = (6.21 \times 10^9)(.75 \times 10^{-12}) = \underline{4.66 \times 10^{-3}}$

$B_1^J = 15.70 \times 10^{-3} = \underline{.0157}$, $\frac{B_1^J}{Y_0} = \frac{.0157}{.0200} = \underline{.785}$

10/18/63 CONT. FROM p. 87

FROM TABLE I

$\frac{b_1}{Y_0} = \underset{1.42}{\cancel{1.38}}$, THEN $J_{01} = \sqrt{\frac{G_A b_1 w}{g_0 g_1 w_1'}}$

$\therefore b_1 = (\overset{1.42}{\cancel{1.38}})(.02) = \overset{.0284}{\cancel{.0276}}$

$$J_{01} = \sqrt{\frac{(.04)(\overset{.0284}{\cancel{.0276}})(0.20)}{(1)(1.1088)\ 1}} = \sqrt{\underset{2.05}{\cancel{2.0}} \times 10^{-4}}$$

$J_{01} = \underset{1.43}{\cancel{1.41}} \times 10^{-2} = \cancel{.0141}$ $.0143$

CHECK ON C_{01}:

$$\omega_0 C_{01} = \frac{J_{01}}{\sqrt{1-\left(\frac{J_{01}}{G_A}\right)^2}} = \frac{.0143}{\sqrt{1-\left(\frac{.0143}{.040}\right)^2}}$$

$\frac{.0141}{.040} = .358$, $(.358)^2 = \underset{.128}{\cancel{.124}}$

$$\begin{array}{r} 1.000 \\ .128 \\ \hline .872 \end{array}, \sqrt{.872} = .935$$

$\omega_0 C_{01} = \frac{\overset{.0143}{\cancel{.0141}}}{.935} = .0151$

$C_{01} = \frac{.0153}{2\pi \times 10^9} = \frac{15.3 \times 10^{-12}}{2\pi}$

$C_{01} = \underset{2.44}{2.4}$ pf. → Too Large!

Try $C_{12} = .5$ pf.

$\omega_0 C_{12} = (6.21 \times 10^9)(.5 \times 10^{-12}) = 3.10 \times 10^{-3}$

$$\begin{array}{r} 6.07 \\ 4.97 \\ 3.10 \\ \hline 14.14 \end{array}$$

$B_1^J = 14.14 \times 10^{-3} = .01414$

$\frac{B_1^J}{Y_0} = \frac{.01414}{.02} = .707$

$\frac{b_1}{Y_0} \cong \cancel{1.41}$ 1.38

$\therefore$ $C_{01} = 2.4$ AGAIN TOO LARGE

10/18/63 CONT. FROM p. 88

TRY $y_0 = \frac{1}{120} = .01$

THEN $b_1 = .0142$, $J_{01} = \sqrt{\frac{(.04)(.0142)(.2)}{1.1088}}$

$J_{01} = 1.015 \times 10^{-2}$

$= \sqrt{1.025 \times 10^{-4}}$

$= .0102$

$\frac{J_{01}}{G_A} = \frac{.0102}{.04} = .255$, $\left(\frac{J_{01}}{G_A}\right)^2 = .065$

$$\begin{array}{r} 1.000 \\ .065 \\ \hline .935 \end{array}$$

$\sqrt{1 - \left(\frac{J_{01}}{G_A}\right)^2} = .967$

$\omega_0 C_{01} = \frac{.0102}{.967} = .0105$

$C_{01} = \frac{.0105}{2\pi \times 10^9} = \underline{1.67} \text{ pf.}$

TRY $C_1^{+} = .4 \text{pf.}$, $\omega_0 C_1^{+} = (6.21 \times 10^9)(.4 \times 10^{-12})$

$= \underline{2.48 \times 10^{-3}}$

ALSO $C_{12} = .5 \text{pf.}$

$\omega_0 C_{12} = (6.21 \times 10^9)(.5 \times 10^{-12}) = 3.11 \times 10^{-3}$

$$\begin{array}{r} 6.07 \\ 3.11 \\ 2.48 \\ \hline 11.66 \end{array}$$

$\therefore B_J' = .01166$, $\frac{B_J'}{Y_0} = \frac{.01166}{.02} = .583$

FROM TABLE: $\frac{b_j}{Y_0} = 1.3$, $b_j = 2.6 \times 10^{-2} = .026$

$J_{01} = \sqrt{\frac{(.04)(.026)(.20)}{1.109}} = \sqrt{1.88 \times 10^{-4}} = 1.37 \times 10^{-2}$

$= .0137$

$\frac{J_{01}}{G_A} = \frac{.0137}{.04} = .342$, $(.342)^2 = .117$

$$\begin{array}{r} 1.000 \\ .117 \\ \hline .883 \end{array}$$

$\omega_0 C_{01} = \frac{.0137}{.94} = .0146$, $C_{01} = \frac{.0146}{2\pi \times 10^9} = 2.32 \text{ pf.}$ $\sqrt{.883} = .94$

10/21/63 CONT. FROM p. 89

CONSIDER $G_A = \frac{1}{35\Omega} = .0286$, C_{01} STILL AT 1pf.

$$\frac{\omega_0 C_{01}}{G_A} = (1.98\pi \times 10^{-3})(35) = .218$$

$$\begin{array}{r} 1.1000 \\ \underline{1.048} \\ .952 \end{array}$$

$$\left(\frac{\omega_0 C_{01}}{G_A}\right)^2 = .0475$$

$$1 + \left(\frac{\omega_0 C_{01}}{G_A}\right)^2 = \text{[illegible]}\ 1.048$$

$$\frac{\omega_0 C_{01}}{1+\left(\frac{\omega_0 C_{01}}{G_A}\right)^2} = \frac{1.98\pi \times 10^{-3}}{1.048} = \underline{5.93 \times 10^{-3}}$$

WITH $C_1^t = .4$ pf.

$$\omega_0 C_1^t = \underline{2.48 \times 10^{-3}}$$

ALSO $C_{12} = .5$ pf., $\omega_0 C_{12} = \underline{3.11 \times 10^{-3}}$

ADDING THEM TOGETHER:

$$\begin{array}{r} 5.93 \\ 2.48 \\ \underline{3.11} \\ 11.52 \times 10^{-3} \end{array}$$

$$\therefore B_1^J = .0115$$

WITH $Y_0 = \frac{1}{50\Omega} = .02$

$$\frac{B_1^J}{Y_0} = \frac{.0115}{.020} = \underline{.575}$$

FROM GRAPH $\frac{b_1}{Y_0} = 1.30$, $b_1 = .026$

$$J_{01} = \sqrt{\frac{(.0286)(.026)(.2)}{1.109}} = \sqrt{1.34 \times 10^{-4}}$$

$3\times10^{-2}\cdot 2\times10^{-2}\cdot(.2)$

1.2×10^{-4}

$$J_{01} = 1.16 \times 10^{-2} = \underline{.0116}$$

10/21/63 CONT. FROM p. 90

$$\frac{J_{01}}{G_A} = \frac{.0116}{.0286} = .405 \,, \quad \left(\frac{J_{01}}{G_A}\right)^2 = .164$$

$$1 - \left(\frac{J_{01}}{G_A}\right)^2 = .836 \,, \quad \sqrt{1 - \left(\frac{J_{01}}{G_A}\right)^2} = .915$$

$$\begin{array}{r} 1.000 \\ .164 \\ \hline .836 \end{array}$$

$$\omega_0 C_{01} = \frac{J_{01}}{\sqrt{1 - \left(\frac{J_{01}}{G_A}\right)^2}} = \frac{.0116}{.915} = .0127$$

$$C_{01} = \frac{.0127}{6.21 \times 10^9} = \underline{2.04\,pf.}$$

TRY W = .15 FOR LAST ATTEMPT

$$J_{01} = \sqrt{\frac{(.0286)(.026)(.15)}{1.109}} = \sqrt{1.005 \times 10^{-4}} \cong .010$$

ALSO TRY .2 db RIPPLE $g_1 = 1.30$

$$J_{01} = \sqrt{\frac{(.0286)(.026)(.15)}{1.30}} = \sqrt{.855 \times 10^{-4}} = .925 \times 10^{-2} = .00925$$

$$\frac{J_{01}}{G_A} = \frac{.00925}{.0286} = .323 \,, \quad \left(\frac{J_{01}}{G_A}\right)^2 = .1045$$

$$\begin{array}{r} 1.000 \\ .105 \\ \hline .895 \end{array}$$

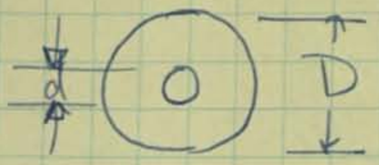
$$\sqrt{1 - \left(\frac{J_{01}}{G_A}\right)^2} = .947$$

$$\frac{J_{01}}{\sqrt{1 - \left(\frac{J_{01}}{G_A}\right)^2}} = \frac{.00925}{.947} = .00976$$

$$C_{01} = \frac{.00976}{6.21 \times 10^9} = \underline{1.57\,pf.}$$

10/21/63 CONT. FROM p. 91

GEOMETRY OF Y_0 LINE: (AIR)



$$\frac{D}{d} = \frac{\frac{1}{8}}{\frac{1}{32}} = 4$$

$$Z_0 = 138 \log 4 = (138)(.603) = \underline{83.2\,\Omega}$$

$Y_0 = .012$

NOW CONSIDER .2 db RIPPLE, $g_1 = 1.30$, $G_A = \frac{1}{35\Omega}$

$C_{12} = .5$ pf.
$C_{01} = 1.0$ pf.
$C_1^* = .4$ pf.

$B_1^J = .0115$

$$\frac{B_1^J}{Y_0} = \frac{.0115}{.012} = 0.958 \rightarrow \text{TOO LARGE}$$

TRY $d = \frac{1}{16}$, $\frac{D}{d} = 2$, $\log 2 = .302$

$$Z_0 = (138)(.302) = \underline{41.6\,\Omega}.$$

WITH TEFLON $\sqrt{\epsilon_r} = 1.45$ $Z_0 = \frac{41.6}{1.45} = 28.8$

$Y_0 = .024$

$$\frac{B_1^J}{Y_0} = \frac{.0115}{.024} = \underline{.48}$$

$$\therefore \frac{b_1}{Y_0} = 1.25, \quad b_1 = (1.25)(.024) = .030$$

FROM HERE $\frac{b_1}{Y_0} = 1.55$, $b_1 = (1.55)(.012) = .0186$

THEN $$J_{01} = \sqrt{\frac{(.0286)(.0186)(.15)}{1.30}} = \sqrt{.613 \times 10^{-4}} = .00783$$

$$\begin{array}{r} 1.000 \\ .075 \\ \hline .925 \end{array}$$

$$\frac{J_{01}}{G_A} = \frac{.00783}{.0286} = .274, \quad \left(\frac{J_{01}}{G_A}\right)^2 = .075$$

$$1 - \left(\frac{J_{01}}{G_A}\right)^2 = .925, \quad \sqrt{.925} = .963, \quad \frac{J_{01}}{\sqrt{1-\left(\frac{J_{01}}{G_A}\right)^2}} = \frac{.00783}{.963} = \underline{.0085}$$

10/21/63 CONT. FROM p. 92

$$C_{01} = \frac{.00815}{6.21 \times 10^9} = 1.31\,pf.$$

ALSO, FROM GRAPH $\dfrac{l_1}{\frac{\lambda_0}{4}} \simeq .62$

AT 1. Kmc $\dfrac{\lambda_0}{4} \simeq \dfrac{30a}{4} \cdot \dfrac{1}{2.5} = 3''$

$\therefore\ l_1 \simeq (.62)(3)'' = 1.86''$

TO CHECK VALUE OF $C_{01} = 1.3\,pf.$

$$\frac{\omega_0 C_{01}}{G_A} = .218\ \frac{1.3}{1.0} = .283$$

$$\left(\frac{\omega_0 C_{01}}{G_A}\right)^2 = .0801$$

$$\frac{\omega_0 C_{01}}{1+\left(\frac{\omega_0 C_{01}}{G_A}\right)^2} = \frac{(1.3)(1.98\pi \times 10^{-3})}{1.0801} = 7.47 \times 10^{-3}$$

THEN $B_1^J = 7.47 \times 10^{-3} + 3.11 \times 10^{-3} + 2.48 \times 10^{-3}$

$= 13.06 \times 10^{-3}$

$$\begin{array}{r} 7.47 \\ 3.11 \\ \underline{2.48} \\ 13.06 \end{array}$$

$Z_0 = 83.2$ $\quad \dfrac{B_1^J}{Y_0} = \dfrac{13.06 \times 10^{-3}}{.012} = 1.09$

$\overset{6}{\therefore}$ FROM GRAPH $\dfrac{b_1}{Y_0} = 1.64$, $b_1 = .0197$

$.81 \times 10^{-2}$

$$J_{01} = \sqrt{\frac{(.0286)(.0197)(.15)}{1.30}} = \sqrt{.65 \times 10^{-4}} = .0081$$

$$\frac{J_{01}}{G_A} = \frac{.0081}{.0286} = .283\ ,\ \left(\frac{J_{01}}{G_A}\right)^2 = .080$$

$$\begin{array}{r} 1.000 \\ \underline{.080} \\ .920 \end{array}$$

$\sqrt{.920} = .960$

$$\omega_0 C_{01} = \frac{.0081}{.960} = .0084$$

$$\boxed{C_{01} = \frac{.0084}{6.21 \times 10^9} = \underbrace{1.36\,pf.}}$$

PRETTY GOOD AGREEMENT.

10/21/63 Cont. From p. 93

From Graph Then:-

$\frac{l_1}{\frac{\lambda_0}{4}} \approx .58$, $l_1 \approx (.58)(3.0) = \underline{1.74''}$

Using .2 db Ripple

$g_0 = 1$, $g_1 = 1.3028$, $g_2 = 1.2844$, $g_3 = 1.9761$, $g_4 = .8468$

$g_5 = 1.5386$

So Far $C_{01} = 1.3\,pf.$

$C_1^+ = C_2^+ = C_3^+ = C_4^+ = .4pf.$ } $C_{12} = .5pf.$

$B_2^J = \omega_0 C_{12} + \omega_0 C_2^+ + \omega_0 C_{23}$

$\omega_0 C_{12} = 3.11 \times 10^{-3}$

$\omega_0 C_2^+ = 2.48 \times 10^{-3}$

$$\begin{array}{r} 3.11 \\ 2.48 \\ 3.11 \\ \hline 8.70 \end{array}$$

Select $C_{23} = .5pf.$

$\therefore B_2^J = 8.70 \times 10^{-3}$, $\frac{B_2^J}{Y_0} = \frac{.0087}{.012} = 0.725$

~~$J_{12} = \frac{W}{\omega_1'}\sqrt{\quad}$~~ $\frac{b_2}{Y_0} = 1.39$, $b_2 = (1.39)(.012) = \underline{.0167}$

$J_{12} = \frac{W}{\omega_1'}\sqrt{\frac{b_1 b_2}{g_1 g_2}} = .15\sqrt{\frac{(.0197)(.0167)}{(1.303)(1.284)}} = .15\sqrt{1.965 \times 10^{-4}}$

$J_{12} = (.15)\ 1.402 \times 10^{-2} = \underline{.21 \times 10^{-2}}$

$\omega_0 C_{\cancel{23}\,12} = .21 \times 10^{-2}$

$C_{12} = \frac{.21 \times 10^{-2}}{6.21 \times 10^{9}} = .0338 \times 10^{-11}$

$C_{12} = .338\ pf.$

10/21/63 CONT. FROM p. 94

TRY $C_{12} = .8$ pf., $w_0 C_{12} = (6.21 \times 10^9)(.8 \times 10^{-12})$
$= 4.968 \times 10^{-3}$

THEN $B_2^J = 10.56 \times 10^{-3}$, $\dfrac{B_2^J}{Y_0} = \dfrac{10.56 \times 10^{-3}}{.012}$
$= 0.88$

$$\begin{array}{r} 4.9\overset{7}{\cancel{68}} \\ 3.11 \\ 2.48 \\ \hline 10.56 \end{array}$$

$\dfrac{b_2}{Y_0} = 1.48$, $b_2 = (.012)(1.48) = \underset{\sim}{.0178}$

$$\frac{(.0197)(.0178)}{(1.303)(1.284)} = 2.09 \times 10^{-4}$$

$\sqrt{2.09} \times 10^{-2} = 1.45 \times 10^{-2}$

$J_{12} = (.15)(1.45 \times 10^{-2}) = .218 \times 10^{-2}$

$\&\ C_{12} = .35$ pf.

$B_3^J = w_0 C_{23} + w_0 C_3^1 + w_0 C_{34}$

TRY $C_{12} = .34$ pf ALSO $C_{23} = C_{34} = .5$ pf.

~~B_3 $w_0 C_{12} = (6.21 \times 10^9)(.$~~

$B_3^J = 8.70 \times 10^{-3}$

$$\begin{array}{r} 3.11 \\ 3.11 \\ 2.48 \\ \hline 8.70 \times 10^{-3} \end{array}$$

THEN $b_3 = .0167$

$J_{23} = .15 \sqrt{\dfrac{(.0167)^2}{(1.284)(1.976)}} = (.15)(.0167)\sqrt{.394}$
$(.15)(.0167)(.628)$

$J_{23} = 1.57 \times 10^{-3}$

$w_0 C_{23} = 1.57 \times 10^{-3}$, $C_{23} = \dfrac{1.57 \times 10^{-3}}{6.21 \times 10^9} = \underset{\sim}{.253}$ pf.

GO BACK NOW AND TRY B_2^J WITH STUB TO SUPPRESS $5 w_0$

AGAIN $B_2^J = 8.70 \times 10^{-3}$, $\dfrac{B_2^J}{Y_0} = 0.725$

$\dfrac{b_2}{Y_0} = 1.25$ $b_2 = (1.25)(.012) = .015$

CONT. FROM p. 95 10/22/63

$$J_{12} = .15\sqrt{\frac{(.0197)(.015)}{(1.30)(1.28)}} = .15\sqrt{1.78\times10^{-4}}$$

$$= (.15)\ 1.34\times10^{-2} = .2\times10^{-2} = \underset{\sim}{.0020}$$

$$\omega_0 C_{12} = .002\ , \quad C_{12} = \frac{.002}{6.21\times10^{9}} = \underset{\sim}{0.323}\ pf$$

TO CALCULATE C_{23}

$$B_3^J = \omega_0 C_{23} + \omega_0 C_3^J + \omega_0 C_{34}$$

~~Again~~ Trey $B_3^J = 7.0\times10^{-3}$, $\frac{B_3^J}{Y_0} = \frac{.007}{.012} = .583$

$\therefore b_3$ USING $5\omega_0$ REJECTION GRAPH

$$\frac{b_3}{Y_0} = 1.15\ , \quad b_3 = (1.15)(.012) = .014$$

$$J_{23} = .15\sqrt{\frac{(.015)(.014)}{(1.28)(1.98)}} = .15\sqrt{.828\times10^{-4}} = (.15)(.91)\times10^{-2}$$

$$J_{23} = .136\times10^{-2}$$

$$C_{23} = \frac{.136\times10^{-2}}{6.21\times10^{9}} = \underset{\sim}{.22}\ pf.$$

TO CALCULATE C_{34}

TAKE $B_4^J = 7\times10^{-3}$, $\frac{B_4^J}{Y_0} = .583$

USING $3\omega_0$ REJECTION GRAPH

~~$\frac{b_4}{Y_0} = 1.3$, $b_4 = (1.3)(.012) = \underset{\sim}{.0156}$~~

~~$J_{34} = .15\sqrt{\frac{(.015)(.0156)}{(1.98)(.847)}} = .15\sqrt{1.4\times10^{-4}}$~~

~~$= (.15)(1.18)\times10^{-2} = .177\times10^{-2}$~~

CONT. FROM p. 96 10/22/63

$$\cancel{C_{34} = \frac{.177\times10^{-2}}{6.21\times10^{9}} = .28\ pf.}$$

~~TO CALCULATE C_{45}:~~

USED WRONG EQUA. FOR LAST B_j^J

SO FAR WE HAVE:

$C_{01} = 1.3\ pf.$, $C_{12} = .32\ pf.$, $C_{23} = .25\ pf.$

B_1 3ω_0 REJECTION, B_2 5ω_0 REJECTION, B_3 5ω_0 REJECTION

MUST USE:

$$B_n^J = \left(\omega_0 C_{n-1,n} + \omega_0 C_n^{+} + \frac{\omega_0 C_{n,n+1}}{1+\left(\frac{\omega_0 C_{n,n+1}}{G_B}\right)^2}\right)$$

$$B_4^J = \left[\omega_0 C_{34} + \omega_1 C_4^{+} + \frac{\omega_0 C_{45}}{1+\left(\frac{\omega_1 C_{45}}{G_B}\right)^2}\right]$$

IN THIS CASE $G_B = \frac{1}{50} = .02$, { LET $C_{\cancel{45}\,34} = .5\ pf.$

{ $C_{45} = 1.0\ pf.$

$$\omega_0 C_{45} = (6.21\times10^{9})(1.0\times10^{-12}) = 6.22\times10^{-3}$$

$$\frac{\omega_0 C_{45}}{.02} = \frac{.0062}{.02} = .31,\quad \left(\frac{\omega_0 C_{45}}{G_B}\right)^2 = .096$$

$$B_4^J = 3.11\times10^{-3} + 2.48\times10^{-3} + 5.66\times10^{-3}$$
$$= 11.25\times10^{-3}$$

$$\frac{6.22}{1.096} = 5.66$$

$$\begin{array}{r} 5.66 \\ 2.48 \\ 3.11 \\ \hline 11.25 \end{array}$$

$$\frac{B_4^J}{Y_0} = \frac{11.25\times10^{-3}}{\cancel{.0128}\ .012} = .94$$

$$\frac{.011}{.02}$$

$\frac{b_4}{Y_0} = \cancel{.72}\ 1.56$ FOR 3ω_0 ~~RESONANCE~~ REJECTION.

$$b_4 = \cancel{.72}(1.56)(.012) = .019$$

$$J_{45} = \sqrt{\frac{G_B\, b_4 W}{g_n g_{n+1}\, \omega_1'}} = \sqrt{\frac{(.02)(.019)(.15)}{(.847)(1.54)}} = \sqrt{.438\times10^{-4}\ \cancel{2.91\times10^{-4}}} = .662\ \cancel{1.71}\times10^{-2}$$

CONT. FROM p. 97 10/22/63

$$\omega_0 C_{45} = \frac{J_{45}}{\sqrt{1-\left(\frac{J_{45}}{G_B}\right)^2}} \quad , \quad J_{45} = \underset{.662}{\cancel{1.71}} \times 10^{-2}$$

$$\frac{.017}{.02}$$

$$\frac{J_{45}}{G_B} = \frac{\overset{.662}{\cancel{1.71}}\times 10^{-2}}{.02} = \overset{.331}{\cancel{.855}}$$

$$\left(\frac{J_{45}}{G_B}\right)^2 = \underset{.110}{.730} \quad , \quad \sqrt{.89} = \overset{.945}{\cancel{.52}}$$

$$\begin{array}{r} 1.000 \\ -\ \cancel{.73} \\ \hline \cancel{.27} \end{array} \qquad \begin{array}{r} 1.000 \\ .110 \\ \hline .890 \end{array}$$

$$\omega_1 C_{45} = \frac{\overset{.662}{\cancel{1.71}}\times 10^{-2}}{\cancel{.52}\ .945} = \overset{.7\times 10^{-2}}{\cancel{3.29\times 10^{-2}}}$$

$$C_{45} = \frac{.7\cancel{3}\ \cancel{3.29}\times 10^{-2}}{6.21\times 10^{9}} = \overset{\cancel{.53\times 10^{-11}}}{\cancel{5.3}}\ \text{pf.} \quad 1.13\ \text{pf.}$$

GO BACK & PICK UP J_{34}, B_3

~~$B_3^J = \omega_0 C_{23}$~~ $\quad b_3 = .014$, $\quad b_4 = .019$

$$J_{34} = .15\sqrt{\frac{(.014)(.019)}{(1.97)(.85)}} = .15\sqrt{1.59\times 10^{-4}}$$

$$J_{34} = (.15)(1.26\times 10^{-2}) = .189\times 10^{-2}$$

$$C_{34} = \frac{.189\times 10^{-2}}{6.21\times 10^{9}} = \underline{.305\ \text{pf.}}$$

WE THEN HAVE:

$C_{01} = 1.3$ pf., $C_{12} = .32$ pf., $C_{23} = .22$ pf., $C_{34} = .305$ pf.

& $C_{45} = 5.3$ pf.

AT THIS POINT LET US RUN BACK THRU WITH THESE RESULTING VALUES:

CALCUL. B_1^J USING $C_1^t = .4$ pf. & $C_{12} = .32$ pf., $G_A = .0286$

FROM p. 93 $$\frac{\omega_0 C_{01}}{1+\left(\frac{\omega_0 C_{01}}{G_A}\right)^2} = 7.47\times 10^{-3}$$

CONT. FROM p. 98 10/22/63

$\omega_0 C_{12} = (6.21\times10^{9})(.32\times10^{-12}) = 1.99\times10^{-3}$,

$\omega_0 C_1^{J} = \overset{2.48}{\cancel{.33}}\times10^{-3}$

$B_1^{J} = 7.47\times10^{-3} + \overset{2.48}{\cancel{33}}\times10^{-3} + 1.99\times10^{-3}$

$B_1^{J} = 11.94\times10^{-3}$, $\dfrac{B_1^{J}}{Y_0} = \dfrac{.01194}{.012} = .995$

$$\begin{array}{r} 7.47 \\ 2.48 \\ 1.99 \\ \hline 11.94 \end{array}$$

FROM $3\omega_0$ GRAPH:

$$\boxed{\frac{b_1}{Y_0} = 1.57 \quad , \quad \frac{l_1}{\lambda_0/4} = \underset{\sim\sim\sim}{.86}}$$

$b_1 = (1.57)(.012) = .0189$

$J_{01} = \sqrt{\dfrac{(.0286)(.0189).15}{1.303}} = \sqrt{6.22\times10^{-5}} = \sqrt{.622\times10^{-4}}$

$J_{01} = .79\times10^{-2}$, $\dfrac{J_{01}}{G_A} = \dfrac{.79\times10^{-2}}{.0286} = .276$

$\dfrac{.098}{.03}$

$\left(\dfrac{J_{01}}{G_A}\right)^2 = .0762$, $1 - \left(\dfrac{J_{01}}{G_A}\right)^2 = .238$

$\sqrt{.924} =$ ~~.488~~ $.962$

$$\begin{array}{r} 1.0000 \\ .0762 \\ \hline .9238 \end{array}$$

$\omega_0 C_{01} = \dfrac{\cancel{.488}\ J_{01}}{\sqrt{1-\left(\frac{J_{01}}{G_A}\right)^2}} = \dfrac{.79\times10^{-2}}{.962} = \cancel{1.62\times10^{-2}}\ .82\times10^{-2}$

$C_{01} = \dfrac{.82\times10^{-2}}{6.21\times10^{9}} = \underset{\sim\sim\sim}{1.32\ pf.}$

TO CALCULATE B_{22}^{J} : USING $C_{12} = .32\,pf.$, $C_{23} = .22\,pf.$
$C_2^{J} = .4\,pf.$ & $5\omega_0$ REJECTION

$B_2^{J} = \omega_0 C_{12} + \omega_0 C_2^{J} + \omega_0 C_{23}$, $\omega_0 C_{23} = (6.21\times10^{9})(.22\times10^{-12})$
1.37×10^{-3}

$= 1.99\times10^{-3} + 2.48\times10^{-3} + 1.37\times10^{-3}$

$$\begin{array}{r} 1.37 \\ 2.48 \\ 1.99 \\ \hline 5.84 \end{array}$$

$B_2^{J} = 5.84\times10^{-3}$ $\dfrac{B_2^{J}}{Y_0} = \dfrac{5.84\times10^{-3}}{.012} = 0.487$

From $5\omega_0$ Graph

$\dfrac{b_2}{Y_0} = 1.08$, $b_2 = (1.08)(.012) = \underset{\sim\sim\sim}{.013}$

$\dfrac{l_2}{\frac{\lambda_0}{4}} = \cancel{.59}\ .75$

CONT. FROM p. 99 10/22/63

$$J_{12} = .15\sqrt{\frac{(.0189)(.013)}{(1.303)(1.284)}} = .15\sqrt{1.47\times10^{-4}} = (.15)(1.21\times10^{-2})$$

$$J_{12} = .181\times10^{-2}$$

$$C_{12} = \frac{.181\times10^{-2}}{6.21\times10^{9}} = .292 \text{ pf.}$$

TO CALCULATE B_3^J USING $C_{23} = .22$ pf. $C_{34} = .30$ pf.

$$B_3^J = w_0 C_{23} + w_0 C_3^* + w_0 C_{34}, \quad w_0 C_{34} = (6.21\times10^{9})(3\times10^{-12}) =$$

$$= 1.37\times10^{-3} + 2.48\times10^{-3} + 1.86\times10^{-3}$$

$$B_3^J = 5.71\times10^{-3}, \quad \frac{B_3^J}{Y_0} = \frac{5.71\times10^{-3}}{.021} = .476$$

$$\begin{array}{r} 1.37 \\ 2.48 \\ \underline{1.86} \\ 5.71 \end{array}$$

$$\boxed{\text{\&}\ \frac{l_3}{\frac{\lambda_0}{4}} = .75}$$

.005
.021

AT 5w₀ REJECTION

$$\frac{b_3}{Y_0} = 1.07, \quad b_3 = (1.07)(.012) = .0128 \cong .013$$

$$J_{23} = .15\sqrt{\frac{(.013)(.013)}{(1.284)(1.976)}} = .15\sqrt{.665\times10^{-4}} = (.15)(.816\times10^{-2})$$

$$= .123\times10^{-2}$$

$$C_{23} = \frac{.123\times10^{-2}}{6.21\times10^{9}} = .498 \text{ pf.}$$

TO CALCULATE B_4^J WITH $C_{23} = .198$ pf. $C_{34} = .30$ pf. & $C_{45} = 5.3$ pf.

$$G_B = \frac{1}{50}$$

$(6.21\times10^{9})(1.16\times10^{-12})$

$$w_0 C_{45} = \overset{9.95\times10^{-3}}{3.29\times10^{-2}}, \quad \frac{w_0 C_{45}}{G_B} = \frac{\overset{9.95\times10^{-3}}{\cancel{3.29\times10^{-2}}}}{.02} = \frac{0.498}{\cancel{1.65}}$$

.009
.02

$$\left(\frac{w_0 C_{45}}{G_B}\right)^2 = \overset{.248}{\cancel{2.72}}, \quad \frac{w_0 C_{45}}{1+\left(\frac{w_0 C_{45}}{G_B}\right)^2} = \frac{\overset{9.95\times10^{-3}}{\cancel{3.29\times10^{-2}}}}{\overset{\cancel{3.72}}{1.248}} = \overset{7.98\times10^{-3}}{\cancel{.885\times10^{-2}}} = \overset{7.98}{\cancel{8.85}}\times10^{-3}$$

$$w_0 C_{34} = 1.86\times10^{-3},$$

$$\begin{array}{r} 1.86 \\ \underline{2.48} \\ \cancel{13.19\times10^{-3}} \\ 12.52\times10^{-3} \end{array}$$

$$B_4^J = \cancel{13.19\times10^{-3}} \; 12.52\times10^{-3}$$

CONT. FROM p. 100 10/22/63

$$\frac{B_4^J}{Y_0} = \frac{\overset{12.52\times10^{3}}{\cancel{13.19\times10^{-3}}}}{.012} = \underbrace{1.04}\qquad \frac{l_4}{\frac{\lambda_0}{4}} = \underbrace{.9}$$

FROM $3\omega_0$ GRAPH $\frac{b_4}{Y_0} = 1.60$, $b_4 = (1.60)(.012) = (.0192)$

$$J_{34} = .15\sqrt{\frac{(.013)(.0192)}{(1.976)(.847)}} = .15\sqrt{\overset{\cancel{1.54}}{1.49}\times10^{-4}} = (.15)(1.22\times10^{-2})$$

$$J_{34} = .183\times10^{-2}$$

$$C_{34} = \frac{.183\times10^{-2}}{6.21\times10^{9}} = \underbrace{\overset{.294 \simeq .30}{.30\text{ pf.}}}$$

TO CALCULATE C_{45} , $G_B = .02$

$$J_{45} = \sqrt{\frac{(.02)(.0192)(.15)}{(.847)(1.539)}} = \sqrt{\frac{.442\times10^{-4}}{\cancel{.304}}} = \overset{\cancel{.675}}{.665}\times10^{-2}$$

$$\frac{J_{45}}{G_B} = \frac{.665\times10^{-2}}{.02} = .332$$

$$\left(\frac{J_{45}}{G_B}\right)^2 = .110 \text{ , } \sqrt{1-\left(\frac{J_{45}}{G_B}\right)^2} = .945 \qquad \begin{array}{r} 1.000 \\ .110 \\ \hline .890 \end{array}$$

$$\omega_0 C_{45} = \frac{.665\times10^{-2}}{.945} = .705\times10^{-2}$$

$$C_{45} = \frac{.72\times10^{-2}}{6.21\times10^{9}} = \underbrace{1.13}\text{ pf.}$$

$$\frac{\lambda_0}{4} = \frac{3.0\text{ cm.}}{4}\cdot\frac{1}{2.54} = .294''$$

FINAL TABLE OF VALUES.

C_{01} = 1.32 pf. , $l_1/\frac{\lambda_0}{4}$ = .86 @ $3\omega_0$ REJECTION $l_1 = 2.53$

C_{12} = 0.29 pf. , $l_2/\frac{\lambda_0}{4}$ = .75 @ $5\omega_0$ REJECTION $l_2 = 2.20$

C_{23} = 0.20 pf. , $l_3/\frac{\lambda_0}{4}$ = .75 @ $5\omega_0$ REJECTION $l_3 = 2.20$

C_{34} = 0.30 pf. , $l_4/\frac{\lambda_0}{4}$ = .90 @ $3\omega_0$ REJECTION, $l_4 = 2.65$

C_{45} = 1.13 pf.

$G_A = \frac{1}{35\Omega} = .0286$

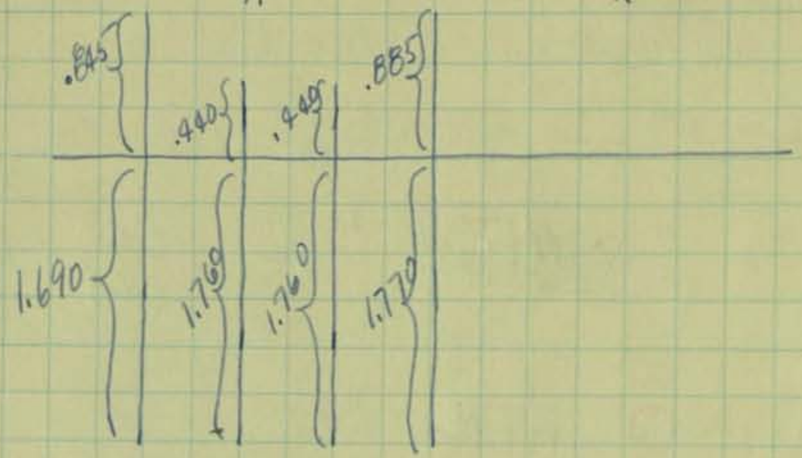
$G_B = \frac{1}{50\Omega} = .020$

CONT. FROM p. 101 10/23/63

FOR THE $3\omega_0$ CASE THE SHORTED STUB IS ~~#~~ 2 TIMES THE OPEN. ‡ FOR THE $5\omega_0$ CASE THE SHORTED STUB IS 4 TIMES THE OPEN STUB.

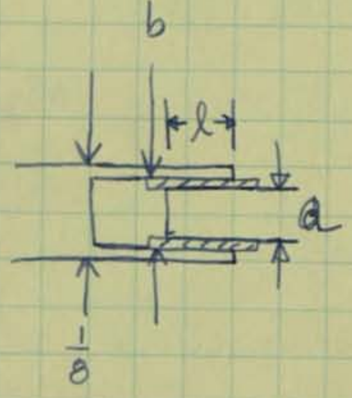
$$\frac{2.53}{3} = .845 \qquad \frac{2.65}{3} = .885 \qquad \frac{2.20}{5} = .440$$

$$\begin{array}{r} .845 \\ 2 \\ \hline 1.690 \end{array} \qquad \begin{array}{r} .885 \\ 2 \\ \hline 1.770 \end{array} \qquad \begin{array}{r} .440 \\ 4 \\ \hline 1.760 \end{array}$$



PHYSICAL SIZE OF CAPACITORS:

ASSUME SERIES CONDUCTOR DIAMETER IS .125



TRY $a = \frac{1}{16} = .0625$, { b =

$$C = \frac{.225\, k\, A}{t}$$

$$\text{OR } C = \frac{.614\, k}{\log_{10} \frac{b}{a}} \quad \mu\mu f/in$$

USING TEFLON .010 THICK

$$C = \frac{(.614)(2.1)}{\log \frac{.0825}{.0625}} = \frac{1.29}{\log 1.32} = \frac{1.29}{.122} = 10.57\ pf./in$$

FOR $C_{01} = 1.32$ pf., $C_{12} = .29$ pf., $C_{23} = .20$ pf.

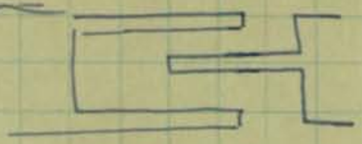
$l_{01} = .125$, $l_{12} = .0274$, $l_{23} = .0190$

$l_{34} = .0284$, $l_{45} = .107$

CONT. FROM p. 102 10/23/63

CONSIDER SMALL CAP. .20 - .29 - .30 PARALLEL

plates



$a = .0625$

$b = .0925$

$$\begin{array}{r} .1250 \\ .0925 \\ \hline 2\,\underline{|.0325} \\ .0162 \end{array}$$

WALL THICKNESS

$\log \frac{b}{a} = \log 1.48 = .172$

$C = \frac{1.29}{.172} = 7.5\ pf/in$

Now $\ell_{12} = \frac{.29}{7.5} = .0387$

CONSIDER PARALLEL PLATE

$$C = \frac{.225\ k\ A}{t}, \quad A = \pi r^2 = \pi \left(\frac{1}{16}\right)^2 = .0123$$

$$t = \frac{(.225)(2.1)(.0123)}{C} = \frac{.00582}{C}$$

$.4 \times 10^{-2}$

FOR $C_{12} = .29$, $t_{12} = .020$

FOR $C_{23} = .20$, $t_{23} = .029 \cong .030$

FOR $C_{34} = .30$, $t_{34} = .020$

10/30/63 1.7 – 2.1 kmc BANDPASS FILTER

$$w = 2\,\frac{2.1-1.7}{2.1+1.7} = 2\,\frac{.4}{3.8} = 21\%$$

$$w_0 = 2\cdot 2\pi\left(\frac{1.7\cdot 2.1}{3.8}\right)\times 10^9 = \underline{11.8^{\times 10^9}\ \text{Rad/sec.}}$$

$$f_0 = \frac{11.8}{2\pi} = \underline{1.88\ \text{kmc.}}$$

WISH TO PRIMARILY REJECT $\frac{f_0}{2} = .94$ kmc

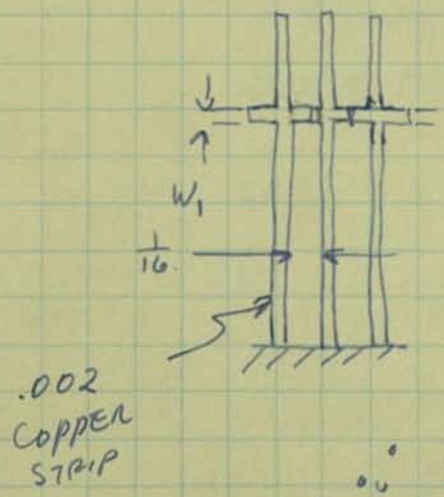
$$w' = \frac{2w_1'}{w}\left(\frac{w-w_0}{w}\right)$$

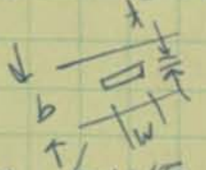
$$w' = \frac{2}{.21}\left(\frac{.94}{.94}\right) \simeq .1$$

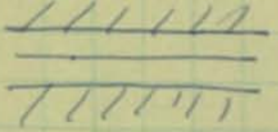
THE LOSS FOR .1 db RIPPLE AT $\frac{f_0}{2}$ IS ABOUT 35 db FOR $n=3$

g VALUES: $g_0 = 1$, $g_1 = 1.0315$, $g_2 = 1.1424$, $g_3 = 1.0315$
$g_4 = 1.0000$

CONSIDER FOLLOWING STRIPLINE CONSTRUCTION.







$\}\ b = \frac{1}{16}$ Ref #1422

FOR 50Ω LINE

$50\sqrt{\epsilon_r} \simeq 80\Omega.$

$\frac{t}{b} = \frac{.002}{.062} \simeq .016$

$\frac{w}{b} = .45$, $w_1 = \frac{.46}{16} = .0287$

$$\therefore\ C_1^t = C_2^t = C_3^t = C^t = \frac{1}{v_p Z_0}\cdot\frac{1}{16}\times 2.54 = \frac{.159}{(1.6)(3\times10^{10})(50)}$$

$$= .066\ \text{pf.} \simeq 0.07\ \text{pf}$$

ALSO LET $G_A = G_B - \frac{1}{50\Omega} = .02$

CONT. FROM p. 104 10/30/63

$$B_1^J = \left(\frac{w_0 C_{01}}{1+\left(\frac{w_0 C_{01}}{G_A}\right)^2} + w_0 C_1^A + w_0 C_{12} \right)$$

TRY $C_{01} = 1.5\,pf$ & $C_{12} = 1.0\,pf.$

$w_0 C_{01} = (11.8 \times 10^9)(1.5 \times 10^{-12})$

$w_0 C_{01} = 17.7 \times 10^{-3}$, $\frac{w_0 C_{01}}{G_A} = \frac{17.7 \times 10^{-3}}{.02} = 0.885$

$\left(\frac{w_0 C_{01}}{G_A}\right)^2 = .783$, $\frac{w_0 C_{01}}{1+\left(\frac{w_0 C_{01}}{G_A}\right)^2} = \frac{17.7 \times 10^{-3}}{1.783} = \underbrace{7.93 \times 10^{-3}}$

$w_0 C^A = (11.8 \times 10^9)(.07 \times 10^{-12}) = .825 \times 10^{-3}$

$w_0 C_{12} = (11.8 \times 10^9)(1.0 \times 10^{-12}) = 11.8 \times 10^{-3}$

$B_1^J = 20.5 \times 10^{-3}$

$$\begin{array}{r} 11.8 \\ .8 \\ 7.9 \\ \hline 20.5 \times 10^{-3} \end{array}$$

Z ALSO LET $Y_0 = .02$

$\frac{B_1^J}{Y_0} = \frac{20.5 \times 10^{-3}}{.02} = 1.025$

FOR $3w_0$ REJECTION:

$\frac{b_1}{Y_0} = 1.57$, $b_1 = (1.57)(.02) = .0314$

$J_{01} = \sqrt{\frac{G_A b_1 w}{g_0 g_1 w_1'}} = \sqrt{\frac{(.02)(.031)(.21)}{1.03}} = \sqrt{1.26 \times 10^{-4}}$

$J_{01} = 1.12 \times 10^{-2}$, $\frac{J_{01}}{G_A} = \frac{1.12 \times 10^{-2}}{.02} = 0.56$

$\left(\frac{J_{01}}{G_A}\right)^2 = .31$

$$\begin{array}{r} 1.000 \\ .31 \\ \hline .690 \end{array}$$

$w_0 C_{01} = \frac{1.12 \times 10^{-2}}{\sqrt{.69}} = \frac{1.12 \times 10^{-2}}{.83} = 1.35 \times 10^{-2}$

$C_{01} = \frac{1.35 \times 10^{-2}}{11.8 \times 10^{+9}} = 1.14\,pf.$

10/30/63 CONT. FROM p. 105

ESTIMATE $C_{12} = .5\,pf.$ & $C_{23} = 1.14\,pf$

$B_2^J = w_0 C_{12} + w_0 C^t + w_0 C_{23}$ $\qquad w_0 C^t = .825 \times 10^{-3}$

$w_0 C_{12} = (11.8 \times 10^9)(.5 \times 10^{-12})$

$= 5.9 \times 10^{-3}, \quad w_0 C_{23} = (11.8 \times 10^9)(1.14 \times 10^{-12}) = 13.5 \times 10^{-3}$

$$\begin{array}{r} 13.5 \\ 5.9 \\ .8 \\ \hline 19.2 \times 10^{-3} \end{array}$$

$B_2^J = 19.2 \times 10^{-3}$

$\dfrac{B_2^J}{Y_0} = \dfrac{19.2 \times 10^{-3}}{.02} = 0.96, \quad \dfrac{l_2}{\lambda_0/4} = .625$

$\dfrac{b_2}{Y_0} = 1.55, \quad b_2 = (1.55)(.02) = .0310$

$J_{12} = \dfrac{W}{w_1'}\sqrt{\dfrac{b_1 b_2}{g_1 g_2}} = .21\sqrt{\dfrac{(.031)(.031)}{(1.031)(1.147}} = \dfrac{(.21)(.031)}{\sqrt{1.18}}$

$J_{12} = \dfrac{.0065}{1.09} = .0060$

$w_0 C_{12} = .0060, \quad C_{12} = \dfrac{.0060}{11.8 \times 10^9} = \dfrac{6}{11.8} \times 10^{-12}$

$C_{12} =$ ~~50~~ $.51\,pf.$

$B_3^J = \left[w_0 C_{23} + w_0 C^t + \dfrac{w_0 C_{34}}{1 + \left(\dfrac{w_0 C_{34}}{G_B}\right)^2} \right]$

ESTIMATE $C_{23} =$ ~~1.0~~ $.5\,pf.$ $\qquad C_{34} = 1.14\,pf.$

$w_0 C_{23} = (11.8 \times 10^9)(.5 \times 10^{-12}) =$ ~~11.8~~ 5.9×10^{-3}

$w_0 C_{34} = 13.5 \times 10^{-3}, \quad \dfrac{w_0 C_{34}}{G_B} = \dfrac{13.5 \times 10^{-3}}{.02} = .675$

$\left(\dfrac{w_0 C_{34}}{G_B}\right)^2 = .455$

11/1/63 CONT. FROM p. 106

$$\frac{w_0 C_{34}}{1+\left(\frac{w_0 C_{34}}{G_B}\right)^2} = \frac{11.8\times10^{-3}}{1.455} = 8.11\times10^{-3}$$

$$\begin{array}{r} 8.11 \\ 5.90 \\ .80 \\ \hline 14.81 \end{array}$$

$B_3^J = 14.81\times10^{-3}$, $\frac{B_3^J}{Y_0} = \frac{14.81\times10^{-3}}{.02} = 0.74$

$\frac{b_3}{Y_0} = 1.42$, $b_3 = .0284$ $\quad \frac{l_3}{\lambda_0/4} = .69$

$$J_{23} = .21\sqrt{\frac{b_2 b_3}{g_2 g_3}} = .21\sqrt{\frac{(.031)(.028)}{(1.147)(1.032)}}$$

$$= .021\sqrt{7.33\times10^{-4}} = (.21)\ 2.71\times10^{-2}$$

$$J_{23} = 5.7\times10^{-3}$$

$$C_{23} = \cancel{11.8\times10^{9}}\ \frac{5.7\times10^{-3}}{11.8\times10^{9}} = .48\ pf.$$

$$J_{34} = \sqrt{\frac{G_B b_3 w}{g_3 g_4 w_1'}} = \sqrt{\frac{(.02)(.028)(.21)}{\cancel{1.147})\ 1.032}} = \sqrt{1.14\times10^{-4}}$$

$$= 1.07\times10^{-2}, \quad \frac{J_{34}}{G_B} = \frac{1.07\times10^{-2}}{.02} = .535$$

$$\left(\frac{J_{34}}{G_B}\right)^2 = .286$$

$$\begin{array}{r} 1.000 \\ .286 \\ \hline .714 \end{array}$$

$$w_0 C_{34} = \frac{1.07\times10^{-2}}{\sqrt{.714}} = \frac{1.07\times10^{-2}}{.845} = 1.27\times10^{-2}$$

$$C_{34} = \frac{12.7\times10^{-3}}{11.8\times10^{9}} = 1.08\ pf.$$

11/7/63 CONT. FROM p. 107

TRY $C_{01} = C_{34} = 1.10$ pf.

$C_{12} = C_{23} = .50$ pf.

$l_1 = l_3 = .69 \frac{\lambda_0}{4}$, $l_2 = .625 \frac{\lambda_0}{4}$

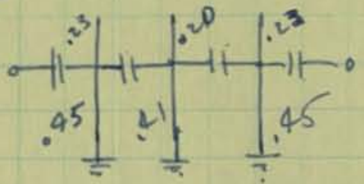
$f_0 = 1.88$ Kmc , $\frac{\lambda_0}{4} = \frac{1}{4} \frac{3 \times 10^{10}}{1.88 \times 10^9 \; 2.54} = 1.57''$ IN AIR

IN REX# 1422

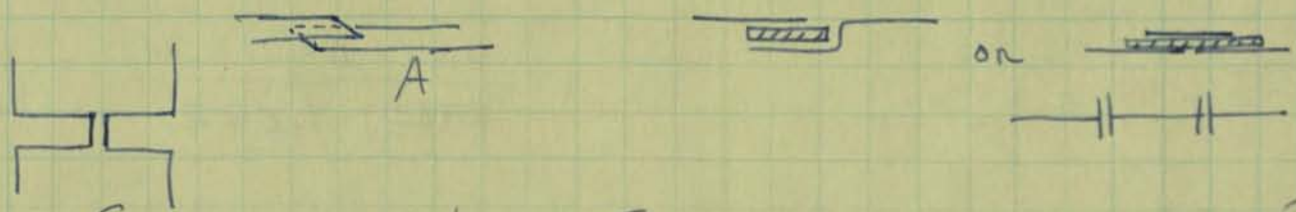
$\frac{\lambda_0}{4} = \frac{1.57}{1.6} = 0.98$

$l_1 = \underset{\sim}{.68} = l_3$, $l_2 = \underset{\sim}{.61}$

$\frac{l_1}{2} \simeq .23$ $\frac{l_2}{2} \cong \underset{\sim}{.20}$



PHYSICAL CONSTRUCTION OF CAPACITIES:



CONSIDER $b = .125$ INSTEAD OF $.0625$

THEN $W = .056$ FOR 50Ω LINE { ALSO USING CONSTRUCTION A.

$C_{pf} = \frac{.225 \; \epsilon_r \; A}{t}$, { $\epsilon_r = 2.1$ - TEFLON

$A = \frac{1}{16} \times .056 = .003$

$t = \frac{(.225)(2.1)(.0035)}{C_{pf}} = \frac{1.65 \times 10^{-3}}{C_{pf}}$

IF $A = \frac{1}{8} \times .056 = .007$, $t = \frac{3.3 \times 10^{-3}}{C_{pf}}$

Run #2

DATE 7-31 1963
EQUIP. USED Boonton 74C-S8
TAKEN BY Clu.
REQUESTED BY J.S.

FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

ENGINEERING DATA

( ) FT.______ CLASS______
REMARKS______
GROUP______

LOT No.	DE.	OP.	GR.	TYPE No.	CL.	TE.	COND.	DATE	ELAPSED TIME	SP.	SP.	

SIGNAL LEVEL AT 15% & 20 mv.
>100 MΩ = ∞

Row	UNIT No.	Co pf.	RMΩ	Row	UNIT	Co pf	RMΩ	ROW	UNIT	Co pf	RMΩ
1 -	1	.41	∞	3	1	.48	∞	5	1	.94	∞
-	2	1.0	30		2	.34	∞		2	.32	∞
-	3	.36	∞		3	.87	20		3	.80	10
-	4	.37	∞		4	.80	∞		4	.81	40
	5	1.0	5		5	.35	.2		5	.77	30
	6	.36	∞		6	9.00	.1		6	.78	∞
	7	.93	100		7	—	—		7	.88	∞
	8	.84	∞		8	.80	∞		8	—	—
	9	.84	∞		9	.76	∞		9	.92	∞
	10	.82	30		10	.74	∞		10	—	—
	11	1.01	∞		11	—	—		11	.31	∞
	12	.82	∞		12	.95	25		12	.78	70
	13	.79	50		13	.76	∞		13	.77	∞
	14	.30	∞		14	.86	∞		14	.71	∞
	15	.83	∞		15	.72	50		15	.81	∞
	16	.80	∞		16	.82	∞		16	.88	50
	17	.89	∞		17	.76	90		17	.30	∞
	18	.97	∞		18	.36	∞		18	.81	∞
	19	.82	85		19	.94	∞		19	—	—
	20	.86	∞		20	1.0	.2		20	.33	∞
	21	.83	∞		21	.76	∞		21	.79	∞
	22	.69	∞		22	.76	∞		22	1.08	∞
	23	.77	∞		23	.65	80		23	.89	∞
	24	—	—		24	1.05	.2		24	.86	∞
	25	.86	∞		25	.84	80		25	.83	∞
2	1	.77	∞	4	1	.76	∞	6	1	.75	∞
	2	—	—		2	.33	10		2	.83	40
	3	.76	15		3	.80	∞		3	—	—
	4	.72	90		4	~~3.15~~	~~.2~~		4	.32	∞
	5	1.8	30		5	.81	∞		5	.84	40
	6	3.5	.5		6	.78	∞		6	1.03	∞
	7	.71	30		7	.38	∞		7	.76	∞
	8	.31	∞		8	.79	30		8	.81	∞
	9	.74	∞		9	.87	50		9	.85	∞
	10	.95	5		10	1.80	∞		10	.74	50
	11	.83	30		11	.84	17		11	.89	∞
	12	.80	∞		12	.87	∞		12	.85	∞
	13	.72	∞		13	.75	∞		13	.93	∞
	14	.71	10		14	.85	13		14	.77	∞
	15	.84	∞		15	.79	∞		15	.79	∞
	16	.80	∞		16	.70	∞		16	.81	∞
	17	.81	∞		17	.34	∞		17	.94	∞
	18	.36	∞		18	—	—		18	1.12	12
	19	.87	∞		19	.77	∞		19	.84	8
	20	—	—		20	.92	∞		20	.71	∞
	21	.76	40		21	—	—		21	.79	∞
	22	.92	∞		22	—	—		22	.82	25
	23	4.	small		23	.85	∞		23	.87	∞
	24	5.5	∞		24	1.01	70		24	.80	∞
	25	.32			25	.70	∞		25	.77	50

.007

UD

$\frac{10}{8}$ 2.5

1 To 4

= 1.3061

= 1

00
34
66

11/7/63 Cont. From p. 108

DATE SEPT. 19 1963
EQUIP. USED BOONTON C. BRIDGE
TAKEN BY O. WETTERHORN
REQUESTED BY A. S.

FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

ENGINEERING DATA

( ) FT. ______ CLASS Run #3
REMARKS 3

GROUP ______

LOT No.	DE	OP.	GR.	TYPE No.	CL.	TE.	COND.	DATE	ELAPSED TIME	SP.	SP.	

LOT No.	UNIT No.	0	1	2	3	4	5	6	7	8	9
		Cov pf.	R-MΩ	UNIT No.	Cov pf.	R-MΩ	UNIT No.	Cov pf.	R-MΩ		
	1	1.132	300	~~50~~			100	.76	120		
	2	.28	∞	51	1.11	120	01	.94	30		
	3	1.07	300	52	1.14	120	02	1.03	200		
	4	1.04	160	53	1.11	302	03	1.05	200		
	5	1.11	260	4	1.05	300	04	1.09	200		
	6	1.15	9	5	1.14	25	05	.99	110		
	7	1.02	100	6	1.07	50	06	.91	300		
	8	.3	∞	7	1.07	90	07	.29	∞		
	9	1.00	250	8	1.05	300	08	1.03	100		
	10	1.18	10	9	1.4	∞	09	1.17	200		
	11	.97	35	60	1.05	300	110	1.05	200		
	12	1.11	70	1	1.07	300					
	13	.94	250	2	.96	300					
	14	1.19	18	3	.71	500					
	15	1.05	300	4	.28	∞					
	16	1.10	300	5	1.18	8					
	17	1.27	∞	6	1.06	180					
	18	1.00	25	7	1.17	18					
	19	1.09	130	8	1.09	400					
	20	1.32	10	9	1.03	70					
	21	.97	120	70	.55	50					
	22	1.07	200	1	1.06	49					
	23	1.13	200	2	1.12	49					
	24	1.02	300	3	1.11	160					
	25	.97	70	4	.26	∞					
	26	1.00	80	5	1.08	200					
	27	1.01	50	6	1.12	200					
	28	1.09	300	7	1.05	200					
	29	.77	300	8	1.09	200					
	30	1.07	300	9	1.00	70					
	31	1.16	300	80	1.06	150					
	32	1.10	300	1	.76	200					
	33	1.07	50	2	1.03	40					
	34	1.1	160	3	.74	0.2					
	35	1.12	4	4	1.05	300					
	36	1.02	200	5	.36	∞					
	37	1.07	17	6	1.03	100					
	38	1.07	300	7	1.05	200					
	39	.31	∞	8	.97	200					
	40	1.11	300	9	1.13	13					
	41	1.–	0.15	90	1.02	200					
	42	.27	8	1	1.01	200					
	43	.74	300	2	1.09	200					
	44	.95	50	3	1.07	300					
	45	1.02	200	4	.31	∞					
	46	1.02	35	5	1.10	200					
	47	.95	80	6	1.49	30					
	48	.34	∞	7	.97	150					
	49	.28	∞	8	1.04	200					
	50	1.02	120	9	1.11	20					

THIS DATA IS **NOT** TAKEN ON THE ORIGIONAL BRIDGE
THE BRIDGE WAS "Calibrated" using diode 163 CP, to approximately the same R-value as given by the origional bridge

R values ABOVE 100 MΩ are I at least 50 MΩ

5 994

.007

$\frac{10}{5}$ 2.5

JD

To 4

= 1.3061

= 1

0

00
34
66

11/7/63 CONT. FROM p. 108

FOR $C_{01} = 1.1$ p.f., $t = \frac{.0033}{1.1} = .003$

FOR $C_{12} = .5$ p.f. $t = \frac{.0033}{.50} = .0066 \simeq .007$

CONSIDER A COMB LINE DESIGN WITH

$\Delta f = 50$ mc

$f_1 = 2.7$ Kmc $\{$ $f_2 = 3.3$ Kmc., $f_0 = 3.0$ Kmc

$f_1 = 2.175$ Kmc $f_2 = 2.225$ Kmc, $f_0 = 2.2$ Kmc

CONSIDER A 4 RESONATOR 50Ω INPUT AND OUTPUT DESIGN.

IF WE SELECT $\theta_0 = \frac{\lambda}{8}$ AT 3.0 Kmc

THEN $l_0 = \frac{1}{8} \frac{3\times10^{10}}{3\times10^{9}\; 2.54} = \underset{\sim}{0.492}$ IN AIR

2.2×10^{9} $.671$

$\frac{10}{8}$ 2.5

$$W = \frac{\omega_2 - \omega_1}{\omega_0} = \frac{f_2 - f_1}{f_0} = \frac{.6^{\;50}}{3.0_{\;2200}} = \underset{\sim}{.20}\ .023$$

LET $\theta_0 = \frac{\pi}{4}$ RAD $= 45^\circ$ $\left.\frac{Y_{aj}}{Y_A} = .677\right\}$ FOR $j = 1$ TO 4

IN THIS CASE $\frac{b_j}{Y_A} = .870$

THEN FOR .1 db RIPPLE $g_0 = 1$, $g_1 = 1.1088$, $g_2 = 1.3061$

$g_3 = 1.7703$, $g_4 = 0.8180$, $g_5 = 1.3554.$, $\{$ $\omega_1' = 1$

$$\frac{G_{T1}}{Y_A} = \frac{w\,\frac{b_1}{Y_A}}{g_0 g_1 \omega_1'} = \frac{(\overset{.023}{.20})(.870)}{(1)(1.1088)} = \underset{\sim}{0.157} \approx .0180$$

$$\sqrt{\frac{G_{T1}}{Y_A}} = .134, \quad 1 - \sqrt{\frac{G_{T1}}{Y_A}} = .866$$

$$\begin{array}{r} 1.000 \\ -.134 \\ \hline .866 \end{array}$$

11/19/63

CONT. FROM p. 109

$$\frac{J_{12}}{Y_A} = \frac{W}{\omega_1'}\sqrt{\frac{(b_1/Y_A)(b_2/Y_A)}{g_1 g_2}} = \frac{(\overset{.023}{.2})(.870)}{\sqrt{(1.1088)(1.3061)}} = \frac{.1740}{\sqrt{1.445}}$$

$$= \frac{.174}{1.201}$$

$$\frac{J_{12}}{Y_A} = \underline{.145} \quad .017$$

$$\frac{J_{23}}{Y_A} = \frac{.174}{\sqrt{(1.3061)(1.7703)}} = \frac{.174}{\sqrt{2.315}} = \frac{.174}{1.520}$$

$$\frac{J_{23}}{Y_A} = \underline{.115} \quad .013$$

$$\frac{J_{34}}{Y_A} = \frac{.174}{\sqrt{(1.7703)(.818)}} = \frac{.174}{\sqrt{1.45}} = \frac{.174}{1.205}$$

$$\frac{J_{34}}{Y_A} = \underline{.145} \quad .017$$

$$\frac{G_{T4}}{Y_A} = \frac{w\left(\frac{b_4}{Y_A}\right)}{g_4 g_5 \omega_1'} = \frac{(.20)(.870)}{(.818)(1.3554)} = \underline{0.157} \quad .018$$

$$\frac{376.7\, Y_A}{\sqrt{\epsilon_r}} = \frac{376.7}{50} = 7.55 \text{ FOR AIR}$$

$$\frac{C_0}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}} Y_A \left(1 - \sqrt{\frac{G_{T1}}{Y_A}}\right)$$

$$= 7.55\left(1 - \sqrt{.157}\right) = 7.55\,(1 - .397) \quad .866$$

$$\begin{array}{r} 1.000 \\ .397 \\ \hline .603 \end{array}$$

$$\frac{C_0}{\epsilon} = 4.55,\ \underline{6.53}$$

ALSO $\frac{C_{n+1}}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}} Y_A \left(1 - \sqrt{\frac{G_{Tn}}{Y_A}}\right) = 4.55$

6.53

11/~~20~~19/63 CONT. FROM p. 110

$$\frac{C_1}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}} Y_A \left(\frac{Y_{a1}}{Y_A} - 1 + \frac{G_{T1}}{Y_A} - \frac{J_{12}}{Y_A} \tan\theta_0 \right) + \frac{C_0}{\epsilon}$$

$$= 7.55 \left(.677 - 1 + \overset{.018}{0.157} - \overset{.017}{.145} \cdot 1 \right) + \overset{6.53}{\cancel{4.55}}$$

$$= \underset{-2.43}{-2.350} + 4.55$$

$$\frac{C_1}{\epsilon} = 2.20 \quad 4.10$$

6.53
-2.43
4.10

4.55
2.35
2.20

.677
.157
.834

Also $$\frac{C_4}{\epsilon} = \frac{376.7\, Y_A}{\sqrt{\epsilon_r}} \left(1 - \sqrt{\frac{G_{Tn}}{Y_A}} \right)$$

.677
.018
.695

-1.145
.834
-.311

-1.017
.695
~~.353~~
-.322

$$\therefore \frac{C_4}{\epsilon} = 2.20 \quad 4.10$$

$$\frac{C_2}{\epsilon} = \frac{376.7\, Y_A}{\sqrt{\epsilon_r}} \left(\frac{Y_{a2}}{Y_A} - \frac{J_{j-1,j}^{1,2}}{Y_A} \tan\theta_0 - \frac{J_{j,j+1}^{2,3}}{Y_A} \tan\theta_0 \right)$$

$$= 7.55 \left(.667 - \overset{.017}{.145} - \overset{.013}{.115} \right) = (7.55)(\overset{.647}{.407})$$

.145
.115
.260

.677
-.030
.647

.667
.260
.407

$$\frac{C_2}{\epsilon} = 3.07 \quad 4.95$$

$$\frac{C_3}{\epsilon} = 7.55 \left(.667 - .115 - .145 \right)$$

$$\frac{C_3}{\epsilon} = 3.07 \quad 4.95$$

FOR THE MUTUAL CAPACITANCES

$$\frac{C_{01}}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}} Y_A - \frac{C_0}{\epsilon} = 7.55 - \underset{6.53}{4.55}$$

7.55
4.55
3.00

7.55
6.53
1.02

$$\frac{C_{01}}{\epsilon} = \underset{1.02}{3.00} = \frac{C_{45}}{\epsilon}$$

112 11/20/63 CONT. FROM p 111

$$\frac{C_{1,2}}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}} Y_A \left(\frac{J_{1,2}}{Y_A} \tan \theta_0 \right)$$

$$= (7.55)(\overset{.017}{.145}) = \underset{\sim\sim}{\overset{.128}{1.095}}$$

$$\frac{C_{2,3}}{\epsilon} = 7.55 \left(\frac{J_{2,3}}{Y_A} \tan \theta_0 \right) = (7.55)(\overset{.013}{.115}) = \underset{\sim\sim}{\overset{.098}{.868}}$$

$$\frac{C_{3,4}}{\epsilon} = 7.55 \left(\frac{J_{3,4}}{Y_A} \tan \theta_0 \right) = (7.55)(\overset{.017}{.145}) = \underset{\sim\sim}{\overset{.128}{1.095}}$$

FOR LUMPED CAPACITIES.

$$C_1^s = Y_A \left(\frac{Y_{a1}}{Y_A} \right) \frac{\cot \theta_0}{\omega_0} \quad , \quad \omega_0 = 2\pi\, \underset{2.2}{3} \times 10^9 = 18.85 \times 10^9$$

$$= 13.80 \times 10^9$$

$$C_1^s \cdots C_n^s = \frac{1}{50} (.677) \frac{1}{\underset{13.80}{18.85 \times 10^9}} = .72 \text{ pf.}$$

.98 pf.

$$\begin{array}{r} 2.50 \\ -1.71 \\ \hline .79 \end{array}$$

TABULATION OF CAPACITIES

$$\frac{C_0}{\epsilon} = \frac{C_5}{\epsilon} = 4.55 \quad 6.53$$

$$\frac{C_1}{\epsilon} = \frac{C_4}{\epsilon} = 2.20 \quad 4.10$$

$$\frac{C_2}{\epsilon} = \frac{C_3}{\epsilon} = 3.07 \quad 4.95$$

$$\frac{C_{01}}{\epsilon} = \frac{C_{45}}{\epsilon} = 3.00 \quad 1.02$$

$$\frac{C_{12}}{\epsilon} = \frac{C_{34}}{\epsilon} = 1.095 \quad .128$$

$$\frac{C_{23}}{\epsilon} = .868 \quad .098$$

$$C_j^s,\ j = 1\text{–}4 = .72 \text{pf.} \quad .98 \text{pf.}$$

$$\frac{W_2}{b} = .3 \left(2.50 - \overset{.85}{\cancel{.46}} - \overset{.86}{\cancel{.54}} \right)$$

$$= (.3)(\overset{.79}{\cancel{1.50}}) = \overset{.237}{\cancel{.450}}$$

$$\boxed{W_2 = \cancel{.112}} \ .059$$

$$\frac{W_3}{b} = .3 \left(2.50 - \overset{1.00}{\cancel{1.08}} \right) = (.3)(1.42)$$

$$= .426$$

$$\boxed{W_3 = \cancel{.112} \quad .059}$$

11/22/63 : CONT. FROM p. 111.

CALCULATION OF PHYSICAL GEOMETRY:

SELECT $t = .125$, IF $\frac{t}{b} = .4$

$$b = \frac{.125}{.4} = \underline{.312}$$

OR SELECT $t = .0625$

$$b = \frac{.0625}{.4} = \underline{.156}$$

IF $b = .25$

$$\frac{t}{b} = \frac{\frac{1}{16}}{\frac{1}{4}} = .25$$

TRY $\frac{t}{b} = .2$

$$b = \frac{.0625}{.2} = \underline{.308}$$

~~if $\frac{t}{b} = .5$, $b = .25$~~

$$\begin{array}{r} 2.05 \\ -1.38 \\ \hline .67 \end{array} \quad \begin{array}{r} 3.27 \\ -1.46 \\ \hline 1.81 \end{array} \quad \cancel{\begin{array}{r} 2.05 \\ -.99 \\ \hline 1.06 \end{array}}$$

FOR S_{01} USING $b = .308$

$\frac{S_{01}}{b} = .1$, $S_{01} = (.1)(.308) = .0308 = S_{45}$

$\frac{S_{12}}{b} = .29$, $S_{12} = (.29)(.308) = .089 = S_{34}$

$\frac{S_{23}}{b} = .35$, $S_{23} = (.35)(.308) = .108$

$$\begin{array}{r} 2.50 \\ -1.00 \\ \hline 1.50 \end{array} \quad \begin{array}{r} 2.50 \\ 1.08 \\ \hline 1.42 \end{array}$$

LET $\frac{t}{b} = .4$, $t = .100$, $b = .25$

FOR $b = .25$

$\frac{S_{01}}{b} = .115$, $S_{01} = .0288$

$\frac{S_{12}}{b} = .31$, $S_{12} = .0775$

$\frac{S_{23}}{b} = .37$, $S_{23} = .0925$

$\boxed{S_{01} = .102}$

$\frac{S_{01}}{b} = \frac{S_{45}}{b} = .41$, $(C_{fe}) = .53$

$\boxed{.27}$

$\frac{S_{12}}{b} = \frac{S_{34}}{b} = 1.07$, $\left(\frac{C_{fe}}{\epsilon}\right)_{12} = .85$

$\boxed{.28}$

$\frac{S_{23}}{b} = \cancel{.45}\ 1.13$, $\left(\frac{C_{fe}}{\epsilon}\right)_{23} = .86$

$\frac{C_f'}{\epsilon} = .93$, $\frac{1}{2}\left(1 - \frac{t}{b}\right) = .3$

A 1.50

$\frac{w_0}{b} = .3\left(\frac{6.53}{2} - .93 - .53\right) = (.3)(1.81) = .543$

$\boxed{W_0 = .1.71}$, $\frac{w_1}{b} = .3(2.05 - .53 - .85) = (.3)(\overset{.67}{\cancel{1.06}}) = \overset{.201}{\cancel{.318}}$, $\boxed{W_1 = \overset{.050}{\cancel{.079}}}$

CONT. FROM p. 113 11/22/63

CALCULATION OF W FOR $b = .25$

$$\frac{C_f'}{\epsilon} = .745$$

$$\left.\frac{C_{fe}'}{\epsilon}\right|_{01} = .145 \quad , \quad \left.\frac{C_{fe}'}{\epsilon}\right|_{12} = .35 \quad , \quad \left.\frac{C_{fe}'}{\epsilon}\right|_{23} = .41$$

$$\frac{W_k}{b} = \frac{1}{2}\left(1 - \frac{t}{b}\right)\left[\frac{1}{2}\left(\frac{C_k}{\epsilon}\right) - \left(\frac{C_{fe}'}{\epsilon}\right)_{k-1,k} - \frac{(C_{fe}')_{k,k+1}}{\epsilon}\right]$$

$$\frac{W_0}{b} = \frac{1}{2}\left(1 - \frac{t}{b}\right)\left[\frac{1}{2}\left(\frac{C_0}{\epsilon}\right) - \frac{C_f'}{\epsilon} - \frac{(C_{fe}')_{01}}{\epsilon}\right]$$

$$= \frac{1}{2}(.75)\left[\underbrace{\tfrac{1}{2}(4.55)}_{2.275} - (.745) - (.145)\right]$$

$$\frac{W_0}{b} = (.375)(1.385) = .519$$

$$\boxed{W_0 = .130}$$

$$\frac{W_1}{b} = .375\left[\underbrace{\tfrac{1}{2}\overset{\frac{C_1}{\epsilon}}{(2.20)}}_{1.10} - \overset{\frac{C_{fe}'}{\epsilon}\big|_{01}}{(.145)} - \overset{\frac{C_{fe}'}{\epsilon}\big|_{12}}{(.35)}\right]$$

$$= (.375)(.605) = .227$$

$$\boxed{W_1 = .0567}$$

$$\frac{W_2}{b} = (.375)\left[\underbrace{\tfrac{1}{2}(3.07)}_{1.535} - (.35) - (.41)\right]$$

$$\frac{W_2}{b} = (.375)(.775) = .291$$

$$\boxed{W_2 = .0726}$$

$$\begin{array}{r} .745 \\ .145 \\ \hline .890 \end{array} \qquad \begin{array}{r} 2.275 \\ .890 \\ \hline 1.385 \end{array} \qquad \begin{array}{r} .145 \\ .350 \\ \hline .495 \end{array} \qquad \begin{array}{r} 1.100 \\ -\ .495 \\ \hline .605 \end{array}$$

$$\begin{array}{r} 1.535 \\ .760 \\ \hline .775 \end{array} \qquad \begin{array}{r} .41 \\ .35 \\ \hline .76 \end{array}$$

CONT. FROM p 114 11/24/63

USE SIMPLE CONSTRUCTION OF TEFLON SHEET FOR END LOADING CAPACITORS.

$$C = \frac{.225\ \epsilon_r\ A}{t} \quad , \text{ WITH } \quad C = .72pf.\ ,\ \epsilon_r = 2.1$$

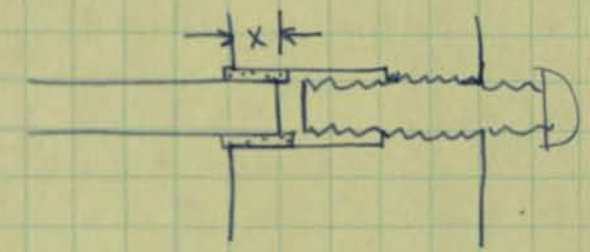
$$\frac{A}{t} = \frac{C}{.225\,\epsilon_r} = \frac{.72}{(.225)(2.1)} = 1.525$$

$$, \quad A = \frac{C\,t}{.225\ \epsilon_r}$$

$$A = \frac{1\ \ .010}{.225\ \ 2.1} \quad \text{USING TEFLON}$$

$$A = \frac{1}{42.2} = .024$$

CONSIDER CONSTRUCTION:



$$l(.112) = .024$$

$$l = \frac{2.4}{11.2} = .21$$

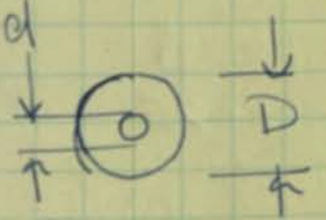
$$\text{IF } t = .005\ ,\quad A = (1.525)(5.0\times10^{-3}) = 7.63\times10^{-3}$$

USING WIDTH OF .060

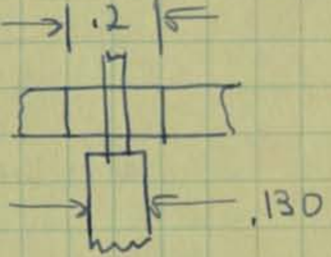
$$l \cdot .060 = 7.63\times10^{-3}\ ,\quad l = \frac{7.63\times\cancel{10^{-3}}}{060.\cancel{\times10^{-3}}} = .127$$

$\therefore$ LET $X \cong \frac{1}{16}$ OR $\cong$ .050 & PICK UP REST OF CAPACITY WITH TUNING SCREW.

FOR 50 Ω INPUT GEOMETRY IN AIR



IF D = .200



LET D = .130 + 2(.025) = .180

$$50 = 138 \log\frac{D}{d}\ ,\quad \frac{D}{d} = 2.3$$

$$\begin{array}{r} .200 \\ .130 \\ \hline 2\,\overline{)\,020} \\ .035 \end{array}$$

$$d = \frac{.180}{2.3} \cong .078$$

1/2/63 INTERDIGITAL FILTER DESIGN.
FOR 4.45 Kmc TO 4.875

$$f_0 = \frac{4.450 + 4.875}{2} = \frac{9.325}{2} = \underset{\sim}{4.663} \text{ kmc.}$$

$$\begin{array}{r} 4.875 \\ 4.450 \\ \hline .425 \end{array} \qquad \frac{.425}{4.875} \overset{u}{=} \underset{\sim}{8.7\%}$$

CONSIDER FILTER CUTOFFS SET AT 4.4 - 4.9 Kmc
WITH $f_0 = 4.625$ Kmc

$$\frac{.500}{4.625} = \underset{\sim}{10.8\%}$$

FUNDAMENTAL & HARMONIC FREQ. ARE THEN (USING 4th HARM.)

FUND. 1.1 Kmc. TO 1.225 Kmc (.550 TO .612 Kmc AT ½ FUND.)

2nd 2.2 Kmc TO 2.450 Kmc

3rd 3.3 Kmc TO 3.675 Kmc

CONSIDER INSTEAD 4.425 Kmc. AND 4.900 Kmc

FUND. 1.106 Kmc TO 1.225 Kmc (.553 - .616)

TO CALCULATE THE NO. OF RESONATORS TO PROVIDE 70 db

$$w' = \frac{2w_1'}{W} \left| \frac{w - w_0}{w_0} \right| \qquad W = \frac{w_2 - w_1}{w_0}$$

$$= \frac{.4750}{4.6625}$$

$$W = .102$$

$$.1019$$

$$w'\Big| = \frac{2 \cdot 1}{.102}$$

at f = .616

$$\frac{w'}{w_1'} = \frac{2}{W} \left| \frac{w - w_0}{w_0} \right|$$

$$= \frac{2}{.102} \left| \frac{.616 - 4.663}{4.663} \right| = \frac{1}{.051} \left(\frac{4.047}{4.663} \right) = 17.0$$

$$\left| \frac{w'}{w_1'} \right| - 1 = 16$$

$$\begin{array}{r} 4.425 \\ 4.900 \\ \hline 2 \,\big\lfloor\, 9.325 \\ 4.663 \end{array}$$

$$\begin{array}{r} 4.900 \\ 4.425 \\ \hline .475 \end{array}$$

$$\begin{array}{r} 663 \\ 616 \\ \hline .047 \end{array}$$

1/3/63 CONT. FROM p 116

CONSIDER STOPPING 3RD HARM

$3f_1 = 3.336 \text{ kmc} - 3.675 \text{ kmc}$

$$\frac{w'}{w_1'} = \frac{2}{.102} \left| \frac{3.675 - 4.663}{4.663} \right| ,$$

$$= \frac{1}{.051} \left(\frac{.988}{4.663} \right) = 4.15$$

$$\begin{array}{r} 4.663 \\ 3.675 \\ \hline .988 \end{array}$$

$$\left| \frac{w'}{w_1'} \right| - 1 = 3.15$$

$n = 5$ GIVES ABOUT 72 db.

$\therefore$ Try $n = 6$. FOR A .01 db RIPPLE.

$w_1' = 1$ $g_0 = 1$

$g_1 = .7813$, $g_2 = 1.3600$, $g_3 = 1.6896$, $g_4 = 1.5350$, $g_5 = 1.4970$

$g_6 = .7098$, $g_7 = 1.1007$.

FROM TABLE II IN MATTHAEI - PGMTT

$$\theta_1 = \frac{\pi}{2} \frac{w_1}{w_0} = \frac{\pi}{2} \left(1 - \frac{w}{2} \right) = (1.57)(.949) = 1.4908$$

$$(1.5708)(.9491)$$

$$\begin{array}{r} 1.0000 \\ .1102 \\ \hline .8898 \end{array}$$

$\theta_1 = \underline{1.4908}$

$$\frac{J_{01}}{Y_A} = \frac{1}{\sqrt{g_0 g_1 w_1'}} = \frac{1}{\sqrt{.7813}} = \frac{1}{.885} \quad .8839$$

$$\begin{array}{r} 1.0000 \\ .0509 \\ \hline .9401 \end{array}$$

$$\begin{array}{r} 1.0000 \\ .0509 \\ \hline .9491 \end{array}$$

$$\frac{J_{01}}{Y_A} = \underline{1.130} \quad \underline{1.1313} , \quad \left(\frac{J_{01}}{Y_A} \right)^2 = \underline{1.28} \quad \underline{1.2798}$$

CORRECTION OF θ_1 $(.07)(.102) = .007133$

$\therefore$ $W = .1090$ $\frac{W}{2} = .0545$

$.15$ $.075$

$$\begin{array}{r} 1.0000 \\ .0545 \\ \hline .9455 \end{array}$$

$$\begin{array}{r} .1019 \\ .0071 \\ \hline 1090 \end{array}$$

$\theta_1 = \underline{\underline{1.4852}}$

1.450

CONT. FROM p. 117 12/4/63

$$\left.\frac{J_{k,k+1}}{Y_A}\right|_{k=1 \text{ To } n-1} = \frac{1}{w_1'\sqrt{g_k g_{k+1}}}$$

$$\frac{J_{12}}{Y_A} = \frac{1}{\sqrt{g_1 g_2}} = \frac{1}{\sqrt{(.7813)(1.3600)}} = \frac{1}{\sqrt{1.06}} = \frac{1}{1.03}$$

$\underline{\underline{1.0626}}$ $\underline{\underline{1.0308}}$

$\frac{J_{12}}{Y_A} = 0.970$ $\underline{\underline{.9701}}$ $\left(\frac{J_{12}}{Y_A}\right)^2 = .942$ $\underline{\underline{.9411}}$

$$\frac{J_{23}}{Y_A} = \frac{1}{\sqrt{(1.3600)(1.6896)}} = \frac{1}{\sqrt{2.30}} = \frac{1}{1.5158} =$$

$\frac{J_{23}}{Y_A} = 0.660$ $\underline{\underline{.6597}}$ $\left(\frac{J_{23}}{Y_A}\right)^2 = .436$ $\underline{\underline{.4352}}$

$$\frac{J_{34}}{Y_A} = \frac{1}{\sqrt{(1.6896)(1.5350)}} = \frac{1}{\sqrt{2.595}} = \frac{1}{1.61}$$

2.5935 1.6104

$\frac{J_{34}}{Y_A} = 0.622$ $\underline{\underline{.6210}}$ [illegible], $\left(\frac{J_{34}}{Y_A}\right)^2 = .387$ $\underline{\underline{.3856}}$

$$\frac{J_{45}}{Y_A} = \frac{1}{\sqrt{(1.535)(1.4970)}} = \frac{1}{\sqrt{2.30}} = \frac{1}{1.5158}$$

2.2978

$\frac{J_{45}}{Y_A} = 0.660$ $\underline{\underline{.6597}}$

$$\frac{J_{56}}{Y_A} = \frac{1}{\sqrt{(1.4970)(.7098)}} = \frac{1}{\sqrt{1.06}} = \frac{1}{1.03}$$

$\frac{J_{56}}{Y_A} = 0.970$

$\frac{J_{67}}{Y_A} = 1.130$

CONT. FROM p. 118 12/4/63

$$N_{k,k+1}\Big|_{k=1\ \text{TO}\ n-1} = \sqrt{\left(\frac{J_{k,k+1}}{Y_A}\right)^2 + \frac{\tan^2\theta_1}{4}}$$

$\theta_1 = 1.4852$ RADIANS $= 85.0954°$

1 RADIAN $= 57.2956°$

FOR SLIDE RULE ACCURACY $\theta_1 = 85.10°$
83.00°

$\tan\theta_1 = 11.664$, $\tan^2\theta_1 = 136.0$
8.144
135.19
66.3

$\frac{\tan^2\theta_1}{4} = 34.0$ 33.80
16.60

sin 1.485
= .9963
2175

Cos 1.485
~~= .0869~~
.08569111

$\tan\theta = 11.627$

$$N_{12} = \sqrt{\left(\frac{J_{12}}{Y_A}\right)^2 + \frac{\tan^2\theta_1}{4}} = \sqrt{.942 + 34.0} = \sqrt{34.94}$$

.941 33.80 34.74
16.60 17.54

$N_{12} = 5.91$ 5.89 4.19

16.60
.94
17.54

33.80
.94
34.74

$$N_{23} = \sqrt{.436 + 34.0} = \sqrt{34.44}$$

34.24

16.60
.44
17.04

33.80
.44
34.24

$N_{23} = 5.87$ 5.85 4.13

$$N_{34} = \sqrt{.387 + 34.0} = \sqrt{34.39}$$

34.19

16.60
.39
16.99

33.80
.39
34.19

$N_{34} = 5.86$ 5.85 4.12

$N_{45} = 5.87$, $N_{56} = 5.91$

TO CALCULATE h FOR MATTHAEIS EQUATIONS.

USING $\frac{2C_{k1,k}}{\epsilon} + \frac{C_k}{\epsilon} + \frac{2C_{k,k+1}}{\epsilon} \mathrel{\hat{=}} 5.4$

FOR $k = n/2$ FOR n EVEN

SINCE $n = 6$, $2\frac{C_{23}}{\epsilon} + \frac{C_3}{\epsilon} + 2\frac{C_{34}}{\epsilon} = 5.4$

CONT. FROM p. 119 12/5/63

$$\left.\frac{C_K}{\epsilon}\right|_{K=2 \text{ TO } n-1} = \frac{376.7}{\sqrt{\epsilon_r}} h Y_A \left[N_{K-1,K} + N_{K,K+1} - \frac{J_{K-1,K}}{Y_A} - \frac{J_{K,K+1}}{Y_A} \right]$$

$$\left\{ \quad \left.\frac{C_{K,K+1}}{\epsilon}\right|_{K=1,\, n-1} = \frac{376.7\, h}{\sqrt{\epsilon_r}} Y_A \left(\frac{J_{K,K+1}}{Y_A} \right)\right.$$

$$2\frac{C_{23}}{\epsilon} + \frac{C_3}{\epsilon} + 2\frac{C_{34}}{\epsilon} = 5.4$$

$$\therefore \frac{376.7}{\sqrt{\epsilon_r}} h Y_A \left\{ 2\frac{J_{23}}{Y_A} + \frac{2J_{34}}{\cancel{Y_A}} + \left[N_{23} + N_{34} - \frac{J_{23}}{Y_A} - \frac{J_{34}}{Y_A} \right] = 5.4\right.$$

$$\frac{376.7}{\sqrt{\epsilon_r}} h Y_A \left[\frac{J_{23}}{Y_A} + \frac{J_{34}}{Y_A} + N_{23} + N_{34} \right] = 5.4$$

$\therefore$ FOR $n=6$

$$h = \frac{5.4}{\frac{376.7}{\sqrt{\epsilon_r}} Y_A \left[\frac{J_{23}}{Y_A} + \frac{J_{34}}{Y_A} + N_{23} + N_{34} \right]}$$

LET $Y_A = \frac{1}{50}$, $\sqrt{\epsilon_r} = 1$

$$h = \frac{(5.4)(50)}{(376.7)\left[.660 + \underset{.621}{.622} + \underset{\underset{4.13}{5.85}}{5.87} + \underset{\underset{4.12}{5.85}}{5.86}\right]}$$

47007

$$\underbrace{h = .055}$$

$$M_1 = \overset{.075}{\overline{\overline{Y_A}}} \left[\frac{J_{01}}{Y_A} \overset{\underline{\underline{.055}}}{\sqrt{h}} + 1 \right] = \frac{1}{50}\left[1.13 \sqrt{\underset{.075}{.055}} + 1 \right] = \frac{1.266}{50}$$

(1.13)(.235)

.266 .274

.310

$\frac{1.310}{50}$

$$M_1 = \underbrace{\overset{\underline{\underline{.0262}}}{.0253}} \quad \underline{\underline{.0253}}$$

$$M_6 = Y_A \left[\frac{J_{6,7}}{Y_A} \sqrt{h} + 1 \right] = \underbrace{.0253}$$

.660
.622
5.870
5.860
13.012
13.008

.660
.622
4.130
4.120
9.532

CONT. FROM p. 120 12/6/63

$$\frac{C_0}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}}\left[2y_A - M_1\right] = (376.7)\left(\frac{2}{50} - .0253\right)$$

$$\frac{C_0}{\epsilon} = \underset{5.537}{\overset{5.27}{5.54}} = \frac{C_7}{\epsilon}$$

.026
.0400
.026
.014

.0400
.0253
.0147

$$\frac{C_1}{\epsilon} = \frac{C_6}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}}\left\{y_A - M_1 + h\,y_A\left[\underset{\underset{11.627}{8.14}}{\frac{\tan\theta_1}{2}} + \left(\frac{J_{01}}{y_A}\right)^2 + N_{12} - \frac{J_{12}}{y_A}\right]\right\}$$

$$= 376.7\left\{.020 - \underset{.026}{.0253} + (\underset{.075}{.055})(.020)\left[\underset{\underset{5.813}{5.832}}{\frac{11.664}{2}} + 1.280 + \underset{5.89}{\overset{4.19}{5.91}} - 0.970\right]\right\}$$

$$= 376.7\left[-.0053 + \underset{.01325}{.00110}(\overset{12.01}{12.05})\right]$$

.0133
−.0053
.0079

5.81
1.28
5.89
12.98
.97
12.01

5.832
1.28
5.91
13.022
.970
12.052

$$\frac{C_1}{\epsilon} = \underset{2.64}{\overset{3.01}{2.98}} = \frac{C_6}{\epsilon}$$

$$\frac{C_2}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}}\,h\,y_A\left[N_{12} + N_{23} - \frac{J_{12}}{y_A} - \frac{J_{23}}{y_A}\right] = \frac{C_5}{\epsilon}$$

$$= (376.7)(\overset{.075}{.055})(.02)\left[\underset{4.19}{\overset{5.89}{5.91}} + \underset{\underset{10.11}{10.15}}{\overset{\overset{5.85}{4.13}}{5.87}} - .970 - .660\right]$$

$$\frac{C_2}{\epsilon} = \underset{3.78}{\overset{4.19}{4.21}} = \frac{C_5}{\epsilon}$$

5.89
5.85
11.74
1.63
10.11

.970
.660
1.630

$$\frac{C_3}{\epsilon} = \frac{C_4}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}}\,\overset{.075}{h}\,y_A\left[\underset{4.13}{\overset{5.85}{N_{23}}} + \underset{4.12}{\overset{5.85}{N_{34}}} - \frac{J_{23}}{y_A} - \frac{\overset{.621}{J_{34}}}{y_A}\right]$$

$$= \underbrace{(376.7)(\underset{.075}{.055})(.02)}_{.565}\left[\underset{\underset{\underset{6.97}{10.42}}{10.45}}{5.87 + 5.86 - .660 - .622}\right]$$

$$\frac{C_3}{\epsilon} = \underset{3.94}{\overset{4.29}{4.33}} = \frac{C_4}{\epsilon}$$

5.91
5.87
11.78
−1.63
10.15

.660
.622
1.282

.660
.621
1.281

5.85
5.85
11.70
1.28
10.42

5.87
5.86
11.73
−1.28
10.45

4.13
4.12
8.25
−1.28
6.97

CONT. FROM p. 121 12/9/63

$$\frac{C_{01}}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}}\left(M_1 - Y_A\right) = 376.7(.0253 - .020)$$

.006

$$\begin{array}{r} 0253 \\ 0200 \\ \hline .0053 \end{array}$$

$$\frac{C_{01}}{\epsilon} = \underset{2.26}{2.00} = \frac{C_{67}}{\epsilon}$$

$$\frac{C_{12}}{\epsilon} = \frac{376.7h\,Y_A}{\sqrt{\epsilon_r}}\left(\frac{J_{12}}{Y_A}\right) = \underbrace{(376.7)(\overset{.075}{.055})(.02)}_{0.415}(.970)$$

.414

$$\frac{C_{12}}{\epsilon} = \frac{C_{56}}{\epsilon} = 0.403 \; \underset{.402}{.550}$$

$$\frac{C_{23}}{\epsilon} = (0.415)\left(\frac{J_{23}}{Y_A}\right) = (0.415)(.660) = .274$$

$$\frac{C_{23}}{\epsilon} = \frac{C_{45}}{\epsilon} = 0.274 \; \underset{.273}{.372}$$

$$\frac{C_{34}}{\epsilon} = (0.415)(.622) = 0.258$$

$$\frac{C_{34}}{\epsilon} = 0.258 \; .257 \; .352$$

GETTING $S_{k,k+1}$ FROM GETSINGERS CHARTS.
(USING $t/b = .2$) $b = .308$

$\frac{C_{01}}{\epsilon} = 2.0$ $\frac{S_{01}}{b} = 0.16$, $S_{01} = .049$

$\frac{C_{12}}{\epsilon} = .403$ $\frac{S_{12}}{b} = 0.57$, $S_{12} = 0.176$

$\frac{C_{23}}{\epsilon} = .274$ $\frac{S_{23}}{b} = 0.69$, $S_{23} = 0.212$

$\frac{C_{34}}{\epsilon} = .258$ $\frac{S_{34}}{b} = 0.71$, $S_{34} = 0.218$

CONT. FROM p. 122 12/10/63

CONSIDER $\frac{t}{b} = .3$, $t = .0625$

$$b = \frac{.0625}{.3} = \underset{\sim}{.208}$$

THEN

$\frac{S_{01}}{b} = .195$ .175 $\qquad S_{01} = .~~04~~05$ .036

$\frac{S_{12}}{b} = .635$ .535 .630 $\qquad S_{12} = .137$ .111

$\frac{S_{23}}{b} = .750$ .655 $\qquad S_{23} = .156$ .136

$\frac{S_{34}}{b} = .770$ .670 $\qquad S_{34} = .160$ .139

NO IMPORTANT CHANGES.

GETTING $\frac{W_K}{b}$ FROM GETSINGER

$$\frac{W_K}{b} = \frac{1}{2}\left(1 - \frac{t}{b}\right)\left[\frac{1}{2}\left(\frac{C_K}{\epsilon}\right) - \frac{(C_{fe}')_{k-1,k}}{\epsilon} - \frac{(C_{fe}')_{k,k+1}}{\epsilon}\right]$$

FOR $k = 1$ TO 6

~~$\frac{W_1}{b} = \frac{1}{2}$~~ $\qquad \frac{1}{2}\left(1 - \frac{t}{b}\right) = \frac{1}{2}(\overset{.7}{\cancel{2}}) = .35$

$(C_{fe}')_{01} = .25$ .23

$(C'_{fe})_{12} = .62$ .56

$(C'_{fe})_{23} = .67$ .62

$(C'_{fe})_{34} = .68$ .63

$$\frac{W_1}{b} = .35\left[\frac{1}{2}\frac{C_1}{\epsilon} - \frac{(C_{fe}')_{01}}{\epsilon} - \frac{(C_{fe}')_{12}}{\epsilon}\right]$$

$$= .35\left[\frac{1}{2}(\overset{2.64}{\overset{3.01}{2.98}}) - \overset{.23}{.25} - \overset{.56}{.62}\right]$$

1.49

(.35)(.62) 1.51

$\frac{W_1}{b} = .217$ .224 .64 .186 $\qquad \underbrace{W_1 = .045}$ .047 .039

$.35\left(1 - \frac{t}{b}\right) = (.35)(.7) = .245$

1.49
.87
.62

$$\frac{W_2}{b} = .35\left[\frac{1}{2}\frac{C_2}{\epsilon} - \frac{(C_{fe}')_{12}}{\epsilon} - \frac{(C_{fe}')_{23}}{\epsilon}\right]$$

$$= .35\left[\frac{1}{2}\ \overset{3.78}{\overset{4.19}{4.21}} - \overset{.56}{.62} - \overset{.62}{.67}\right]$$

2.00
2.11

(.35)(.82) .81

$\frac{W_2}{b} = .287$ .283 .248 $\qquad \underbrace{W_2 = .0595 \simeq .060}$ .059 .052

.62
.67
1.29

2.11
1.29
0.82

$$\frac{W_3}{b} = .35\left[\frac{1}{2}\frac{C_3}{\epsilon} - \frac{(C_{fe}')_{23}}{\epsilon} - \frac{(C_{fe}')_{34}}{\epsilon}\right]$$

$$.35\left[\frac{1}{2}\ \overset{4.29}{4.33} - .67 - .68\right]$$

216
2.15

2.16
1.35
81

67
68
135

(.35)(.81) .80

$\frac{W_3}{b} = .284$ .280 .252 $\qquad \underbrace{W_3 = .059}$ .058 .052

CONT. FROM p. 123 12/10/63

~~w_0~~ APPLYING WIDTH CORRECTION TO $W_1 = .045$

$$\frac{w'}{b} = \frac{(.07)\left(1-t/b\right)+w/b}{1.20} = \frac{(.07)(.7)+\overset{.224}{\overset{.217}{\cancel{.267}}}}{1.20}$$

$$\frac{w'}{b} = \cancel{.188}\ \underset{.227}{.222}\ ,\quad w' = \underset{.041}{.046}$$

$.217$
$.055$
~~.222~~
$.267$

$.224$
$.049$
$.273$

~~SUMMARY OF DIMENSIONS:~~

~~w_1~~ DIMENSIONS OF END COUPLING STUBS

~~$w_2 =$~~
~~w_3~~

$$\frac{w_0}{b} = \frac{1}{2}\left(1-\frac{t}{b}\right)\left[\frac{1}{2}\left(\frac{C_0}{\epsilon}\right)-\frac{C_f'}{\epsilon}-\left(\frac{C_{fe}'}{\epsilon}\right)_{01}\right]$$

FOR $\frac{t}{b} = .3$, $\frac{C_f'}{\epsilon} = .8$

$$\therefore \frac{w_0}{b} = .35\left[\frac{1}{2}\ \underset{2.77}{\overset{5.27}{5.54}} - .8 - \overset{.23}{.25}\right]$$

2.77
-1.05
1.72

$$\frac{w_0}{b} = \overset{.560}{\cancel{.602}}\ ,\quad w_0 = \overset{.117}{\cancel{.125}}$$

SUMMARY OF DIMENSIONS

$w_0 = w_7 = .125\ .117$

$w_1 = w_6 = .046$ ~~.047~~ $.039$ $s_{01} =$ ~~.049~~ $.040$ $.036$

$w_2 = w_5 = .060$ ~~.059~~ $.052$ $s_{12} =$ ~~.176~~ $.137$ $.111$

$w_3 = w_4 = .059$ ~~.058~~ $.052$ $s_{23} =$ ~~.212~~ $.156$ $.136$

$s_{34} =$ ~~.218~~ $.160$ $.139$

CALCULATE RESONATOR LENGTHS

$l_{5.4-5.9} = .464$, $l_{4.45-4.875} = \frac{5.650}{4.663} \times .464 =$

$1.211 \times .464 = .5619$

12/15/64 COMB LINE DESIGN AT X-BAND

$f_1 = 8.5$ Kmc $f_2 = 9.6$ Kmc

TRY 6 RESONATORS : $n=6$

$$w = \frac{\omega_2-\omega_1}{\omega_0} = \frac{9.6-8.5}{9.05} = \frac{1.1}{9.05} = .121 \cong .12$$

FROM p. 109

SELECT $\theta_0 = \frac{\lambda}{8}$ AT 9.05 Kmc.

$$l_0 = \frac{1}{8} \times \frac{3\times10^{10}}{(9.05\times10^9)(2.54)} = 0.163''$$ IN AIR.

SOLVING FOR $\left.\frac{b_j}{Y_A}\right|_{j=1 \text{ to } n}$ $= .870$ AGAIN SINCE $\theta_0 = 45°$ & WE SELECT $\frac{Y_{aj}}{Y_A} = .677$

FOR .1 db RIPPLE, $n=6$, $g_0=1$ $\omega_1'=1$

$g_1 = 1.1681$, $g_2 = 1.4039$, $g_3 = 2.0562$, $g_4 = 1.5170$

$g_5 = 1.9029$, $g_6 = 0.8618$, $g_7 = 1.3554$.

$$\frac{G_{T1}}{Y_A} = \frac{w\,\frac{b_1}{Y_A}}{g_0 g_1 \omega_1'} = \frac{(.12)(.870)}{(1.0)(1.168)} = .0893$$

$$\frac{J_{12}}{Y_A} = .12\,\frac{(.870)}{\sqrt{(1.168)(1.404)}} = \frac{.1045}{\sqrt{1.64}} = \frac{.1045}{1.28}$$

$$\frac{J_{12}}{Y_A} = .0816$$

$$\frac{J_{23}}{Y_A} = \frac{.1045}{\sqrt{(1.404)(2.056)}} = \frac{.1045}{\sqrt{2.890}} = \frac{.1045}{1.7} = .0615$$

1/15/64 CONT. FROM p. 125

$$\frac{J_{34}}{Y_A} = \frac{.1045}{\sqrt{(2.056)(1.517)}} = \frac{.1045}{1.77} = \underline{.059}$$

3.12

$$\frac{J_{45}}{Y_A} = \frac{.1045}{\sqrt{(1.517)(1.903)}} = \frac{.1045}{1.70} = \underline{.0615}$$

2.88

BEING SYMMETRICAL

$$\frac{J_{56}}{Y_A} = \overset{.0816}{\cancel{.089}} \;, \quad \& \quad \frac{G_{T6}}{Y_A} = \frac{G_{T1}}{Y_A} = \underline{.0893}$$

AGAIN, FROM p. 110 $\frac{376.7\, Y_A}{\sqrt{\epsilon_r}} = \underline{7.55}$ FOR AIR

$$\frac{C_0}{\epsilon} = 7.55\left(1 - \sqrt{\frac{G_{T1}}{Y_A}}\right) = 7.55\left(1 - \sqrt{\frac{G_{Tn}}{Y_A}}\right) = \frac{C_{n+1}}{\epsilon}$$

$$\sqrt{\frac{G_{T1}}{Y_A}} = \sqrt{.0893} = \overset{}{\cancel{.284}}\ .299$$

$$\begin{array}{r} 1.000 \\ .284 \\ \hline .716 \end{array} \qquad \begin{array}{r} 1.000 \\ .299 \\ \hline .701 \end{array}$$

$$\frac{C_0}{\epsilon} = \frac{C_7}{\epsilon} = (7.55)(\cancel{.716}\ .701) = \cancel{5.40}\ \boxed{5.28}$$

$$\frac{C_1}{\epsilon} = 7.55\left(.677 - 1 + .089 - .082\right) + \cancel{5.40}\ 5.28$$

$$\begin{array}{r} .089 \\ .677 \\ \hline .766 \end{array} \qquad \begin{array}{r} -1.082 \\ .766 \\ \hline -.316 \end{array}$$

$$= -2.38 + 5.40$$

$$\begin{array}{r} 5.40 \\ -2.38 \\ \hline 3.02 \end{array} \qquad \begin{array}{r} 5.28 \\ -2.38 \\ \hline 2.90 \end{array}$$

$$\frac{C_1}{\epsilon} = \frac{C_6}{\epsilon} = \cancel{3.02}\ \boxed{2.90}$$

$$\frac{C_2}{\epsilon} = \frac{C_5}{\epsilon} = 7.55\left(.677 - \frac{J_{12}}{Y_A} - \frac{J_{23}}{Y_A}\right) = 7.55(.677 - .082 - .062)$$

$$\frac{C_2}{\epsilon} = \frac{C_5}{\epsilon} = \underline{4.02}$$

$$\begin{array}{r} .677 \\ -.144 \\ \hline .533 \end{array} \qquad \begin{array}{r} .082 \\ .062 \\ \hline .144 \end{array}$$

$$\frac{C_3}{\epsilon} = \frac{C_4}{\epsilon} = 7.55(.677 - .062 - .059)$$

$$= \underline{4.20}$$

$$\begin{array}{r} .677 \\ -.121 \\ \hline .556 \end{array} \qquad \begin{array}{r} .059 \\ .062 \\ \hline .121 \end{array}$$

1/16/64 Cont. From p 126

$$\frac{C_{01}}{\epsilon} = \frac{376.7\, Y_A}{\sqrt{\epsilon_r}} - \frac{C_0}{\epsilon} = 7.55 - \cancel{5.40}\ \ 5.28$$

$$\begin{array}{r} 7.55 \\ 5.28 \\ \hline 2.27 \end{array} \qquad \begin{array}{r} 7.55 \\ 5.40 \\ \hline 2.15 \end{array}$$

$$\frac{C_{01}}{\epsilon} = \frac{C_{67}}{\epsilon} = \cancel{2.15}\ \ 2.27$$

$$\frac{C_{12}}{\epsilon} = 7.55\,(.082) = .620 = \frac{C_{56}}{\epsilon}$$

$$\frac{C_{23}}{\epsilon} = 7.55\,(.062) = .465 = \frac{C_{45}}{\epsilon}$$

$$\frac{C_{34}}{\epsilon} = 7.55\,(.059) = .445$$

For $C_j^s = Y_A \left(\frac{Y_{aj}}{Y_A}\right) \frac{\cot\theta_0}{\omega_0}$

$$\omega_0 = 2\pi f_0 = 2\pi\, 9.05\times10^9 = 56.8\times10^9$$

$$C_j^s = \frac{(.02)(.677)}{56.8\times10^9} = .238\ pf.$$

$$\frac{(2)(\cancel{7})}{\cancel{56}\times10^{-9}} \times10^{-3} \qquad 8 \qquad .25\times10^{-12}$$

From p. 113

$t = 1/16$, $b = 1/4$, $\frac{t}{b} = .25$

$\frac{C_{01}}{\epsilon} = \cancel{2.15}\ 2.27$ $\frac{S_{01}}{b} = \cancel{.165}\ .155$ $S_{01} = \cancel{.041}\ .039$, $\left(\frac{C'_{fe}}{\epsilon}\right)_{01} = \cancel{.20}\ .19$

$\frac{C_{12}}{\epsilon} = 0.620$ $\frac{S_{12}}{b} = .470$ $S_{12} = .117$, $\left(\frac{C'_{fe}}{\epsilon}\right)_{12} = .48$

$\frac{C_{23}}{\epsilon} = 0.465$ $\frac{S_{23}}{b} = .560$ $S_{23} = .140$, $\left(\frac{C'_{fe}}{\epsilon}\right)_{23} = .54$

$\frac{C_{34}}{\epsilon} = 0.445$ $\frac{S_{34}}{b} = .576$ $S_{34} = .144$, $\left(\frac{C'_{fe}}{\epsilon}\right)_{34} = .55$

1/16/64 CONT. FROM p. 127

CALCULATION OF WIDTHS FROM p. 114

$$\frac{W_0}{b} = \frac{1}{2}\left(1-\frac{t}{b}\right)\left[\frac{1}{2}\left(\frac{C_0}{\epsilon}\right) - \frac{C_f'}{\epsilon} - \frac{(C_{fe}')_{01}}{\epsilon}\right]$$

$$\frac{C_f'}{\epsilon} = .745 \quad , \quad \frac{(C_{fe}')_{01}}{\epsilon} = \overset{.19}{\cancel{.20}}$$

$$\frac{1}{2}\left(1-\frac{t}{b}\right) = \frac{1}{2}(.75) = .375$$

$$\frac{W_0}{b} = .375\left(\frac{\overset{5.28}{\cancel{5.40}}}{2}\underset{\cancel{2.70}}{{}_{2.64}} - .745 - .\overset{19}{\cancel{20}}\right)$$

$$\underbrace{\frac{W_0}{b} = \overset{.637}{\cancel{.656}} \quad , \quad \boxed{W_0 = \overset{.159\ \pm}{\cancel{.164}} = W_7}}$$

$$\frac{W_K}{b} = \frac{1}{2}\left(1-\frac{t}{b}\right)\left[\frac{1}{2}\left(\frac{C_K}{\epsilon}\right) - \frac{(C_{fe}')_{K-1,K}}{\epsilon} - \frac{(C_{fe}')_{K,K+1}}{\epsilon}\right]$$

$$\frac{W_1}{b} = .375\left(\frac{\overset{2.90}{\cancel{3.02}}}{2}\underset{\cancel{1.51}}{{}_{1.45}} - \overset{.19}{\cancel{.20}} - .48\right)$$

$$\frac{W_1}{b} = \overset{.292}{\cancel{.0311}} \quad , \quad \boxed{\underline{W_1 = \overset{.073\ \pm}{.077}} = W_6}$$

$$\frac{W_2}{b} = .375\left(\frac{4.02}{2}_{2.01} - .48 - .54\right)$$

$$\frac{W_2}{b} = .371 \quad , \quad \underline{W_2 = .093} = W_5$$

$$\frac{W_3}{b} = .375\left(\frac{4.20}{2}_{2.10} - .54 - .55\right)$$

$$\frac{W_3}{b} = .379 \quad , \quad \underline{W_3 = .095 = W_4}$$

IN SUMMARY:

$$\left\{\begin{aligned} W_0 &= W_7 = \overset{.159}{\cancel{.164}} \\ W_1 &= W_6 = \overset{.073}{\cancel{.077}} \\ W_2 &= W_5 = .093 \\ W_3 &= W_4 = .095 \end{aligned}\right\}$$

2.64
.94
1.70

.75
.19
.94

$(1-\frac{t}{b})$ 0.35
$(.35)(.75)$
= .262
=

2.70
− .95
1.75

1.45
.67
.78

1.51
− .68
.83

2.01
− 1.02
.99

2.10
− 1.09
1.01

$t = .100 \quad b = .250 \quad \frac{t}{b} = .4$ $\qquad \frac{C_f'}{\epsilon} = .930$

$\frac{C_{01}}{\epsilon} = 2.27 \quad \frac{S_{01}}{b} = .210 \quad S_{01} = .052 \quad \left(\frac{C_{f\epsilon 01}'}{\epsilon}\right) = .31$

$\frac{C_{12}}{\epsilon} = .620 \quad \frac{S_{12}}{b} = .550 \quad S_{12} = .137 \quad \left(\frac{C_{f\epsilon}'}{\epsilon}\right)_{12} = .64$

$\frac{C_{23}}{\epsilon =} .465 \quad \frac{S_{23}}{b} = .635 \quad S_{23} = .159 \quad \left(\frac{C_{f\epsilon}'}{\epsilon}\right)_{23} = .70$

$\frac{C_{34}}{\epsilon} = .445 \quad \frac{S_{34}}{b} = .65 \quad S_{34} = .162 \quad \left(\frac{C_{f\epsilon}}{\epsilon}\right)_{34} = .710$

$= .45 \, pf/in$

$$\frac{W_0}{b} = \frac{1}{2}\left(1 - \frac{t}{b}\right)\left[\frac{1}{2}\left(\frac{C_0}{\epsilon}\right) - \frac{C_\epsilon'}{\epsilon} - \left(\frac{C_{f\epsilon}'}{\epsilon}\right)_{01}\right]$$

pf/in

$$\frac{1}{2}\left(1 - \frac{t}{b}\right) = \frac{1}{2}(.60) = .300$$

$$\frac{W_0}{b} = .3\left(\frac{5.2\cancel{7}}{\cancel{2}\,2.70} - .930 - .31\right)$$

$$\begin{array}{r} .930 \\ .310 \\ \hline 1.240 \end{array} \qquad \begin{array}{r} 2.70 \\ -1.24 \\ \hline 1.46 \\ .3 \\ \hline .438 \end{array}$$

$$\frac{W_0}{b} = .438 \quad \boxed{W_0 = .110 = W_7}$$

$pf/ = .34 \, pf/in$

$$\frac{W_1}{b} = .3\left(\frac{2.9\cancel{0}}{\cancel{2}\,1.45} - .31 - .64\right) = .150$$

$$\begin{array}{r} .31 \\ .64 \\ \hline .95 \end{array} \qquad \begin{array}{r} 1.45 \\ -.95 \\ \hline .50 \\ .3 \\ \hline .150 \end{array}$$

$.64 \, pf/in$

$$\frac{W_1}{b} = .150 \quad \boxed{W_{\cancel{0}1} = .038 = W_6}$$

$A = \frac{.12}{(22.5)(2.1)} = .0025$

$x = .034$

using $W_1 = .073$

$x = \frac{}{85. \times 10^{-3}} \cong .025$

1/16/64 CONT. FROM p. 127

CALCULATION OF WIDTHS FROM p. 114

$$\frac{W_0}{b} = \frac{1}{2}\left(1-\frac{t}{b}\right)\left[\frac{1}{2}\left(\frac{C_0}{\epsilon}\right) - \frac{C_f'}{\epsilon} - \frac{(C_{fe}')_{01}}{\epsilon}\right]$$

$$\frac{C_f'}{\epsilon} = .745 \quad , \quad \frac{(C_{fe}')_{01}}{\epsilon} = \overset{.19}{\cancel{.20}}$$

$$\frac{1}{2}\left(1-\frac{t}{b}\right) = \frac{1}{2}(.75) = .375$$

$$\frac{W_0}{b} = .375\left(\frac{\overset{5.28}{\cancel{5.40}}}{\underset{\cancel{2.70}\ \ 2.64}{2}} - .745 - .\overset{19}{\cancel{20}}\right)$$

$$\underbrace{\frac{W_0}{b} = \overset{.637}{\cancel{.656}} \quad , \quad \boxed{W_0 = \overset{.159}{\cancel{.164}} = W_7}}$$

$$\frac{W_k}{b} = \frac{1}{2}\left(1-\frac{t}{b}\right)\left[\frac{1}{2}\left(\frac{C_k}{\epsilon}\right) - \frac{(C_{fe}')_{k-1,k}}{\epsilon} - \frac{(C_{fe}')_{k,k+1}}{\epsilon}\right]$$

$$\frac{W_1}{b} = .375\left(\frac{\overset{2.90}{\cancel{3.02}}}{\underset{\cancel{1.51}\ \ 1.45}{2}} - \overset{.19}{\cancel{.20}} - .48\right)$$

$$\frac{W_1}{b} = \overset{.292}{\cancel{.0311}} \quad , \quad \boxed{\underline{W_1 =} \ \overset{.073}{.077} = W_6}$$

$$\frac{W_2}{b} = .375\left(\frac{4.02}{\underset{2.01}{2}} - .48 - .54\right)$$

$$\frac{W_2}{b} = .371 \quad , \quad \underline{W_2 = .093} = W_5$$

$$\frac{W_3}{b} = .375\left(\frac{4.20}{\underset{2.10}{2}} - .54 - .55\right)$$

$$\frac{W_3}{b} = .379 \quad , \quad \underline{W_3 = .095 = W_4}$$

IN SUMMARY:

$$\left\{\begin{aligned} W_0 &= W_7 = \overset{.159}{\cancel{.164}} \\ W_1 &= W_6 = \overset{.073}{\cancel{.077}} \\ W_2 &= W_5 = .093 \\ W_3 &= W_4 = .095 \end{aligned}\right\}$$

$$\begin{array}{r} 2.64 \\ -\ .94 \\ \hline 1.70 \end{array} \qquad \begin{array}{r} .75 \\ .19 \\ \hline .94 \end{array}$$

$$0.35\left(1-\frac{t}{b}\right) = (.35)(.75) = .262$$

$$\begin{array}{r} 2.70 \\ -\ .95 \\ \hline 1.75 \end{array}$$

$$\begin{array}{r} 1.45 \\ .67 \\ \hline .78 \end{array} \qquad \begin{array}{r} 1.51 \\ -\ .68 \\ \hline .83 \end{array}$$

$$\begin{array}{r} 2.01 \\ -1.02 \\ \hline .99 \end{array}$$

$$\begin{array}{r} 2.10 \\ -1.09 \\ \hline 1.01 \end{array}$$

$\frac{w_2}{b} = .3\left(\frac{4.02}{2}{}_{2.01} - .64 - .70\right) = .198$

$\frac{w_2}{b} = .198$ $\boxed{w_2 = .050 = w_5}$

$\frac{w_3}{b} = .3\left(\frac{4.20}{2}{}_{2.10} - .70 - .71\right) =$

$\frac{w_3}{b} = .207$ $\boxed{w_3 = .052 = w_4}$

$w_0 = w_7$ .110

$w_1 = w_6$ .038

$w_2 = w_5$ .050

$w_3 = w_4$ .052

$$\begin{array}{r} .64 \\ .70 \\ \hline 1.34 \end{array} \quad \begin{array}{r} 2.01 \\ -1.34 \\ \hline .66 \\ .3 \\ \hline .198 \end{array}$$

$$\begin{array}{r} .70 \\ .71 \\ \hline 1.41 \end{array} \quad \begin{array}{r} 2.10 \\ -1.41 \\ \hline .69 \\ .3 \\ \hline .207 \end{array}$$

= .45 pf/in

pf/in

pf/in = .34 pf/in

.64 pf/in

025

83. x10 –

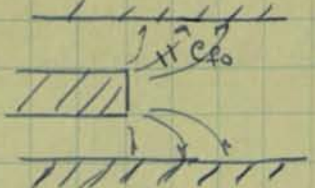
$A = \frac{.12}{(22.5)(2.1)} = .00$

$\alpha = .034$

$w_1 = .073$

1/16/64 CONT. FROM p. 128

TO CALCULATE EFFECT OF FRINGING CAPACITY OF END OF RESONATORS:

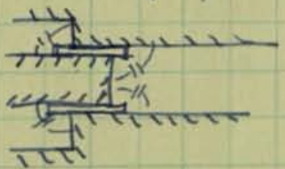


$\frac{C'_{f_0}}{\epsilon} = .745 \cong .75$

$\epsilon = 8.85 \times 10^{-12}$ FARADS / METER

$\therefore C'_{f_0} = 6.6 \times 10^{-12}$ FARADS/METER = 6.6 pf./M.

FOR .005" TEFLON SPACER



$\frac{t}{b} = \frac{.0625}{.0725} = .86$

$\frac{C'_{f_0}}{\epsilon} \cong 2.0$, $C'_{f_0} = 17.7 \times 10^{-12}$ f./m. = .177 pf/cm. = .45 pf/in

IN TEFLON $\cong$ .75 pf./in ~~FOUR~~ 2 CAPACITORS 3.0 pf/in

FOR n=1 $(\overset{1.5}{\cancel{3.0}})(.077) =$ ~~.25~~ pf. .13 pf

n=2 $(\overset{1.5}{\cancel{3.0}})(.093) =$ ~~.28~~ pf. .14 pf.

n=3 $(\overset{1.5}{\cancel{3.0}})(.095) =$ ~~.28~~ pf. .14 pf.

TRY .010 SPACERS or .020

P. 115 $\frac{t}{b} = \frac{.0625}{.0825} = .76$, $\frac{C_{f_0}}{\epsilon} \cong 1.5$, $C_{f_0} = .133$ pf/cm = .34 pf/in

$2C_{f_0} = .64$ pf/in

$C'_{h} = .72 \times \frac{3}{9.05}$ ~~n=1~~

$\cong .24$ pf APPEARS TO BE ABOUT 0.1 pf.

TRY C = 0.1 PARALLEL PLATE CAPACITY

FROM p. 115 $\frac{A}{t} = \frac{(.1)}{(.225)(2.1)}$ .01 $= 212 \times 10^{-3}$

USE .085 AS AVE. WIDTH. $\therefore x \cdot .085 = 2.12 \times 10^{-3}$

$x = \frac{2.12 \times 10^{-3}}{85 \times 10^{-3}} \cong \underset{\sim}{.025}$

C = .12 pf

$A = \frac{.12}{(.225)(2.1)} = .0025$, for t = .010

$x = .034$

using $W_1 = .073$

CONT. FROM p. ~~129~~ 109 1/27/64

LET $f_1 = \frac{2.7}{3} = 9$ kmc , $f_2 = \frac{3.3}{3} = 1.1$ kmc.

$f_0 = 1.0$ kmc. , $\underline{\omega_0 = 6.28 \times 10^9}$

IN THIS CASE EVERYTHING STAYS THE SAME

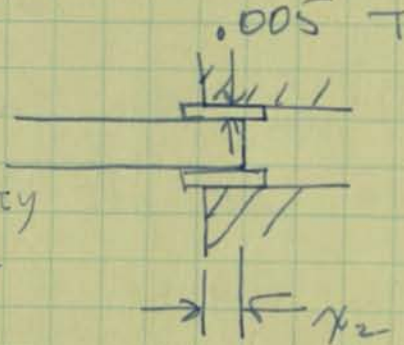
EXCEPT: $C_j^s \Big|_{n=1 \text{ to } 4} = Y_A \left(\frac{Y_{aj}}{Y_A}\right) \frac{\cot\theta_0}{\omega_0}$

$C_j^s = (.02)(.677) \frac{1}{6.28 \times 10^9} = \frac{(2)(6.77)}{6.28}$ pf.

$\boxed{C_j^s = 2.16 \text{ pf.}}$

AND $\frac{\lambda_0}{8} = \frac{1}{8} \frac{3 \times 10^{10}}{1 \times 10^9 \; 2.54} = \underline{1.48''}$

at 1kmc



SINCE THIS IS 3X CAPACITY USED ON p. 115 AND WE WOUND UP WITH ABOUT $x_1 = \text{~~.040~~}\ 035$

TRY $x_2 = .105 \simeq \underline{.110}$

COMB LINE FOR 1720 mc TO 1800 mc. SOURCE

1/29/64

$f_0 = 1760$ mc.

1720
1800
2 ⌊3520
1760

TRY 10% BANDWIDTH

$.1 = \frac{\Delta f}{1760}$, $\Delta f = 176$ mc, $\frac{\Delta f}{2} = 88$ mc.

1760
+ 88
1848

1760
− 88
1672

$f_1 = 1672$ mc, $f_2 = 1848$ mc.

$\underset{\sim\sim\sim}{w = 0.1}$, $\omega_0 = 1.76 \times 10^9 \; 2\pi$

$\omega_0 = \underset{\sim\sim\sim}{11.1 \times 10^9}$

LET $\underset{\sim\sim\sim}{\Theta_0 = 45^\circ}$ $\qquad \underset{\sim\sim\sim}{\frac{Y_{aj}}{Y_A} = .677}$

IN THIS CASE: $\underset{\sim\sim\sim}{\frac{b_j}{Y_A} = .870}$

$$C_j^s = Y_A \left(\frac{Y_{aj}}{Y_A}\right) \frac{\cot\Theta_0}{\omega_0} = \frac{(.02)(.677)}{11.1 \times 10^9} = \frac{(2)(6.77)}{11.1} \text{ pf.}$$

$$\underset{\sim\sim\sim}{C_j^s = 1.22 \text{ pf}}$$

IF $\Theta_0 = 30^\circ$, $\cot 30^\circ = \frac{1.732}{1}$

$$C_j^s = \frac{(.02)(.677)}{11.1} \; 1.732 = \underset{\sim\sim\sim}{2.11} \text{ pf.}$$

THEN $\frac{b_j}{Y_A} = .677 \left(\frac{1.732 + \frac{\pi}{6} \cdot 4}{2} \right)$

$\frac{6.28}{3} = 2.09$
1.73
3.82

$\frac{b_j}{Y_A} = (.677)(1.91) = \underset{\sim\sim\sim}{1.29}$

LET $n = 4$ $\quad$ .1 db RIPPLE.
1.1088, 1.3061, 1.7703, 0.8180, 1.3554

$$\frac{G_{T1}}{Y_A} = \frac{w \frac{b_1}{Y_A}}{g_0 g_1 \omega_1'} = \frac{(.1)(1.29)}{1.109} = \underset{\sim\sim\sim}{0.116}$$

$$\frac{J_{12}}{Y_A} = \frac{(.1)(1.29)}{\sqrt{(1.109)(1.306)}} = \frac{.129}{\sqrt{1.45}} = \frac{.129}{1.205} = \underset{\sim\sim\sim}{.107}$$

CONT. FROM p. 131 1/29/64

$$\frac{C_0}{\epsilon} = 7.53\left(1 - \sqrt{.116}\right) = 7.53\,(.659)$$

$$\begin{array}{r} 1.0000 \\ .341 \\ \hline .659 \end{array}$$

$$\underbrace{\frac{C_0}{\epsilon} = 4.97}$$

$$\frac{C_1}{\epsilon} = 7.53\left[.677 - 1 + .116 - \overset{.0618}{(.107)\cdot\left(\frac{1}{1.732}\right)}\right] + \frac{C_0}{\epsilon}$$

$$\begin{array}{r} .677 \\ .116 \\ \hline .793 \end{array} \qquad \begin{array}{r} -1.062 \\ .793 \\ \hline -.269 \end{array}$$

$$= -2.02 + 4.97$$

$$\begin{array}{r} 4.97 \\ 2.02 \\ \hline 2.95 \end{array}$$

$$\boxed{\frac{C_1}{\epsilon} = 2.95}$$

$$\frac{C_{01}}{\epsilon} = 7.53 - 4.97$$

$$\begin{array}{r} 7.53 \\ 4.97 \\ \hline 2.56 \end{array}$$

$$\boxed{\frac{C_{01}}{\epsilon} = 2.56}$$

USING $b = .25$, $t = \frac{1}{16}$, $t/b = .25$

$$\therefore \underbrace{\frac{S_{01}}{b} = .140}, \quad \boxed{S_{01} = \overset{.035}{\cancel{.1039}}}, \quad \frac{C'_{fc}}{\epsilon}\Big|_{01} = \underbrace{.175}$$

$$\frac{C_{12}}{\epsilon} = 7.53\left(.107 \cdot \frac{1}{1.732}\right) = (7.53)(.062) = \underbrace{.467}$$

$$\frac{S_{12}}{b} = .555, \quad \boxed{S_{12} = .139} \qquad \frac{C'_{fc}}{\epsilon}\Big|_{12} = \cancel{.440}\ \underbrace{.540}$$

$$\frac{W_1}{b} = .375\left[\frac{1}{2}\cdot\overset{1.475}{2.95} - .175 - .540\right]$$

$$\begin{array}{r} .540 \\ .175 \\ \hline .715 \end{array}$$

$$\frac{W_1}{b} = (.375)(.760) = .285$$

$$\begin{array}{r} 1.475 \\ -\ .715 \\ \hline .760 \end{array}$$

$$\boxed{W_1 = .071}$$

CONT. FROM p. 132   1/29/64

$$\frac{J_{23}}{Y_A} = (.1)\frac{(1.29)}{\sqrt{(1.306)(1.770)^2}} = \frac{.129}{\sqrt{2.31}} = \frac{.129}{1.52}$$

$$\underline{\frac{J_{23}}{Y_A} = .085}$$

$$\frac{C_2}{\epsilon} = 7.53\left(.677 - {.107}/{1.732} - {.085}/{1.732}\right)$$

$$= 7.53\,(.677 - .062 - .049) = (7.53)(.566)$$

$$\begin{array}{r} 062 \\ .049 \\ \hline .111 \end{array} \qquad \begin{array}{r} .677 \\ -.111 \\ \hline .566 \end{array}$$

$$\underline{\frac{C_2}{\epsilon} = 4.26}$$

$$\frac{C_{23}}{\epsilon} = 7.53\left(\frac{.085}{1.732}\right) = (7.53)(.049) = .369$$

$$\underline{\frac{C_{23}}{\epsilon} = 0.369}$$

$$\frac{S_{23}}{b} = .63,\ \boxed{S_{23} = .158} \qquad \frac{C'_{fe}}{\epsilon}\Big|_{23} = .570$$

$$\frac{W_2}{b} = .375\left[\frac{1}{2}\cdot\overset{2.13}{4.26} - .540 - .570\right] = (.375)(1.02)$$

$$\begin{array}{r} 2.13 \\ -1.11 \\ \hline 1.02 \end{array} \qquad \begin{array}{r} .570 \\ .540 \\ \hline 1.110 \end{array}$$

$$\frac{W_2}{b} = .382,\ \boxed{W_2 = .095}$$

$$\frac{W_0}{b} = .375\left[\frac{1}{2}\cdot\overset{2.49}{4.97} - .745 - .175\right]$$

$$\begin{array}{r} .745 \\ .175 \\ \hline .920 \end{array} \qquad \begin{array}{r} 2.49 \\ -.92 \\ \hline 1.57 \end{array}$$

$$\frac{W_0}{b} = .588,\ \boxed{W_0 = .147}$$

$w_0 = w_5 = .147$

$s_{01} = .035$

$w_1 = w_4 = .071$

$s_{12} = .139$

$w_2 = w_3 = .095$

$s_{23} = .158$

$$l = \frac{1}{12}\,\frac{3\times10^{10}}{1.76\times10^{9}\ 2.54}$$

$$\underline{l = .56}$$

CONT. FROM p. 133. 1/29/64

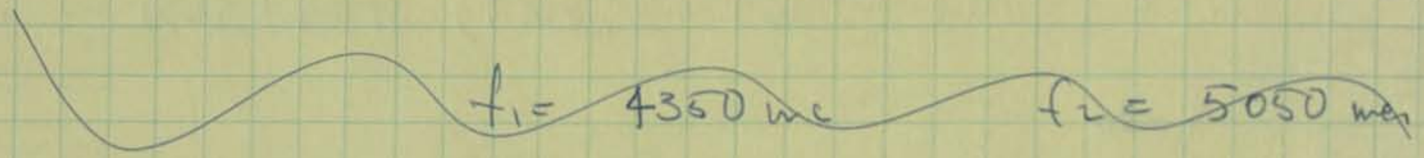
TO CALCULATE END CAPACITY LOADING:

$C_j^s = 2.01$ pf.

ASSUME. WIDTH OF .060

FROM p. 115 $x = .058$ FOR $C = .72$ pf.

IN THIS CASE TRY $x = .140$ FOR $C = 2.11$ pf.



X-BAND WAVEGUIDE IMPEDANCE AT OUTPUT FREQ. OF 8.5 - 9.6 Kmc (AT 9.0 Kmc)

$$Z_0 = 377 \frac{\lambda_g}{\lambda} \frac{\pi}{2} \frac{b}{a} \qquad \frac{\lambda_g}{\lambda} \doteq 1.46$$

FOR RG 52/U WAVEGUIDE

$$Z_0 = (377)(1.46) \frac{\pi}{2} \frac{.4}{.9} = \underline{384 \,\Omega.}$$

IF WE SELECT $Z_0 = 200\,\Omega$. { FIND b

$$b = \frac{Z_0}{377} \frac{\lambda}{\lambda_g} \frac{2}{\pi} a$$

$$b = (200) \frac{1}{1.46} \frac{2}{\pi} .9 = \underline{.208}$$

2/27/64 CONSIDER 2.7-3.2 Kmc OUTPUT WITH 6 RESONATORS.

FOR .1 db RIPPLE $g_0 = 1, \omega_1' = 1$

1.1681, 1.4039, 2.0562, 1.5170, 1.9029, 0.8618, 1.3554.

TRY $\Theta_0 = 30°$ $\cot 30° = 1.732$

$f_1 = 2.7$ kmc
$f_2 = 3.2$ kmc

TO FIND LOSS AT 3.375 kmc.

$$W = \frac{\omega_2 - \omega_1}{\omega_0} = \frac{.500}{2.95} = .169$$

$2 \,\underline{|\, 5.9}$
2.95

$$\frac{\omega'}{\omega_1'} = \frac{2}{W}\left(\frac{\omega - \omega_0}{\omega_0}\right) = \frac{2}{.169}\left(\frac{3.375 - 2.950}{2.950}\right)$$

3.375
$\underline{2.950}$
425

$$\frac{\omega'}{\omega_1'} = (11.8)\left(\frac{.425}{2.950}\right) = 1.7$$

$$\left|\frac{\omega'}{\omega_1'}\right| - 1 = .7$$

FOR 6 RESONATORS $L_A = 36$ db

NEED $n = 9$ FOR 65 db
OR $n = 8$ FOR 56 db.

1.1897, 1.4346, 2.1199, 1.6010, 2.1699, 1.5640, 1.9444, .8778
1.3554

TRY $\Theta_0 = 30°$, & $\frac{Y_{ai}}{Y_A} = .677$, $Y_A = .02$

$$\frac{b_i}{Y_A} = .677\left(\frac{\cot 30° + .523 \csc^2 30°}{2}\right)$$

$$\frac{b_i}{Y_A} = (.677)\left[\frac{1.732 + (.523)(4)}{2}\right]$$

$$= (.677)(1.912) = 1.295$$

2.092
$\underline{1.732}$
$2 \,\underline{|\, 3.824}$
1.912

$$\frac{G_{T1}}{Y_A} = \frac{W \frac{b_1}{Y_A}}{g_0 g_1 \omega_1'} = \frac{(.169)(1.295)}{1.1897} = 0.184$$

CONT. FROM p. 135

$$\frac{J_{12}}{Y_A} = \frac{(.169)(1.295)}{\sqrt{(1.19)(1.435)}} = \frac{.219}{\sqrt{1.71}} = \frac{.219}{1.31}$$

$$\boxed{J_{12}/Y_A = .167} = \underbrace{J_{78}/Y_A}$$

$$J_{23} = \frac{.219}{\sqrt{(1.435)(2.12)}} = \frac{.219}{\sqrt{3.04}} = \frac{.219}{1.745}$$

$$\boxed{J_{23}/Y_A = .126} = \underbrace{J_{67}/Y_A}$$

$$J_{34} = \frac{.219}{\sqrt{(2.12)(1.601)}} = \frac{.219}{\sqrt{3.40}} = \frac{.219}{1.845}$$

$$\boxed{J_{34}/Y_A = .119} = \underbrace{J_{56}/Y_A}$$

$$J_{45} = \frac{.219}{\sqrt{(1.601)(2.17)}} = \frac{.219}{\sqrt{3.47}} = \frac{.219}{1.865}$$

$$\boxed{J_{45}/Y_A = .117}$$

$$\frac{C_0}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}} Y_A \left(1 - \sqrt{\frac{G_{T1}}{Y_A}}\right)$$

$$= 7.53\left(1 - \sqrt{.184}\right) = (7.53)(.57)$$

$$\begin{array}{r} 1.00 \\ .43 \\ \hline .57 \end{array}$$

$$\underbrace{\frac{C_0}{\epsilon} = 4.30} = \frac{C_9}{\epsilon}$$

$$\begin{array}{r} .184 \\ +.677 \\ \hline .861 \end{array} \qquad \begin{array}{r} -1.096 \\ .861 \\ \hline -.235 \end{array}$$

$$\frac{C_1}{\epsilon} = 7.53\left[.677 - 1 + .184 - (.167)\overset{.096}{\frac{1}{1.732}}\right] + 4.30$$

$$= -1.73 + 4.30$$

$$\boxed{C_1/\epsilon = 2.57} = C_8/\epsilon$$

$$\begin{array}{r} 4.30 \\ 1.73 \\ \hline 2.57 \end{array}$$

CONT. FROM p. 136 3/3/64

$$\frac{C_2}{\epsilon} = 7.53\left[.677 - \overset{.096}{.167\frac{1}{1.732}} - \overset{.073}{.126\frac{1}{1.732}}\right]$$

$$= (7.53)(.508)$$

$$\boxed{C_2/\epsilon = 3.83} = C_7/\epsilon$$

$$\begin{array}{r} .096 \\ .073 \\ \hline .169 \end{array} \qquad \begin{array}{r} .677 \\ -.169 \\ \hline .508 \end{array}$$

$$\frac{C_3}{\epsilon} = 7.53\left[.677 - .073 - \underset{\boxed{.069}}{\frac{.119}{1.732}}\right]$$

$$\frac{C_3}{\epsilon} = (7.53)(.535)$$

$$\boxed{C_3/\epsilon = 4.03} = C_6/\epsilon$$

$$\begin{array}{r} .073 \\ .069 \\ \hline .142 \end{array} \qquad \begin{array}{r} .677 \\ -.142 \\ \hline .535 \end{array}$$

$$\frac{C_4}{\epsilon} = 7.53\left[.677 - .069 - \underset{\boxed{.068}}{\frac{.117}{1.732}}\right]$$

$$\frac{C_4}{\epsilon} = (7.53)(.540)$$

$$\boxed{C_4/\epsilon = 4.07} = C_5/\epsilon$$

$$\begin{array}{r} 068 \\ 069 \\ \hline .137 \end{array} \qquad \begin{array}{r} .677 \\ -.137 \\ \hline .540 \end{array}$$

$$\frac{C_{01}}{\epsilon} = 7.53 - 4.30$$

$$\begin{array}{r} 7.53 \\ 4.30 \\ \hline 3.23 \end{array}$$

$$\boxed{\frac{C_{01}}{\epsilon} = \frac{C_{89}}{\epsilon} = 3.23}$$

$$\frac{C_{12}}{\epsilon} = 7.53\left(\overset{.096}{\frac{.167}{1.732}}\right) = \underline{.723}$$

$$\frac{C_{23}}{\epsilon} = 7.53\left(\overset{.073}{\frac{.126}{1.732}}\right) = \underline{.550}$$

$$\frac{C_{34}}{\epsilon} = 7.53\left(\overset{.069}{\frac{.119}{1.732}}\right) = \underline{.520}$$

$$\frac{C_{45}}{\epsilon} = 7.53\left(\overset{.068}{\frac{.117}{1.732}}\right) = \underline{.512}$$

3/3/64 CONT. FROM p. 137

$f_0 = 2.95$ Kmc., $\omega_0 = 2\pi f_0$

$= 18.5 \times 10^9 = 1.85 \times 10^{10}$

$$C_j^S = Y_A \left(\frac{Y_{aj}}{Y_A}\right) \frac{\cot\theta_0}{\omega_0} = (.02)(.677)\frac{(1.732)}{1.85\times10^{10}}$$

$$\boxed{C_j^S = 1.27 \text{ pf.}}$$

$(.02)(.7)(\cancel{2})$

$\cancel{2}$

$.014 \times 10^{-10}$

1.4×10^{-12}

AGAIN USING $b = .25$ & $t = \frac{1}{16}$

$\frac{t}{b} = .25$

FORMULA FOR STRIP WIDTHS CONTAINS:

$\frac{1}{2}\left(1 - \frac{t}{b}\right) = .375$ & $\frac{C_f'}{\epsilon} = .745$

$\frac{C_{01}}{\epsilon} = 3.23$, $\frac{S_{01}}{b} = .105$, $\left(\frac{C_{fe}'}{\epsilon}\right)_{01} = .135$

$\frac{C_{12}}{\epsilon} = .723$, $\frac{S_{12}}{b} = .430$, $\left(\frac{C_{fe}'}{\epsilon}\right)_{12} = .460$

$\frac{C_{23}}{\epsilon} = .550$, $\frac{S_{23}}{b} = .510$, $\left(\frac{C_{fe}'}{\epsilon}\right)_{23} = .510$

$\frac{C_{34}}{\epsilon} = .520$, $\frac{S_{34}}{b} = .525$, $\left(\frac{C_{fe}'}{\epsilon}\right)_{34} = .520$

$\frac{C_{45}}{\epsilon} = .512$, $\frac{S_{45}}{b} = .530$, $\left(\frac{C_{fe}'}{\epsilon}\right)_{45} = .520$

$w_0/b = .476$

$w_1/b = .259$

$w_2/b = .365$

$w_3/b = .369$

$w_4/b = .373$

$$\frac{w_0}{b} = .375\left[\frac{1}{2}\underset{2.15}{(4.30)} - .745 - .135\right]$$

$= (.375)(1.27) = .476$

$\begin{array}{r} .745 \\ .135 \\ \hline .880 \end{array}$ $\begin{array}{r} 2.150 \\ .880 \\ \hline 1.270 \end{array}$

$$\frac{w_1}{b} = .375\left[\frac{1}{2}\underset{1.285}{(2.57)} - .135 - .460\right]$$

$(.375)(.690) = .259$

$\begin{array}{r} 1.285 \\ .595 \\ \hline .690 \end{array}$ $\begin{array}{r} .135 \\ .460 \\ \hline .595 \end{array}$

$$\frac{w_2}{b} = .375\left[\frac{1}{2}\underset{1.915}{(3.83)} - .460 - .510\right]$$

$= (.375)(945) = .365$

$\begin{array}{r} .460 \\ .510 \\ \hline .970 \end{array}$ $\begin{array}{r} 1.915 \\ .970 \\ \hline .945 \end{array}$

3/3/64 CONT. FROM p. 138

$$\frac{W_3}{b} = .375\left[\underset{2.015}{\tfrac{1}{2}(4.03)} - .510 - .520\right]$$

$$=(.375)(.985) = .369$$

$$\begin{array}{r} 2.015 \\ 1.030 \\ \hline .985 \end{array} \qquad \begin{array}{r} 510 \\ 520 \\ \hline 1,030 \end{array}$$

$$\frac{W_4}{b} = .375\left[\underset{2.035}{\tfrac{1}{2}(4.07)} - .520 - .520\right]$$

$$(.375)(.995) = .373$$

$$\begin{array}{r} 2035 \\ 1.040 \\ \hline .995 \end{array}$$

TABULATING:

$S_{01} = S_{89} = .0262 \triangleq .026$, $W_0 = W_9 = .119$

$S_{12} = S_{78} = .1075 \triangleq .108$, $W_1 = W_8 = .065$

$S_{23} = S_{67} = .1275 \triangleq .128$, $W_2 = W_7 = .091$

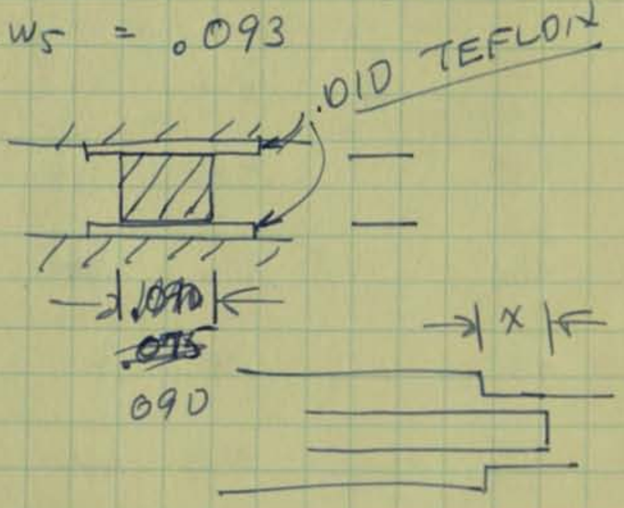
$S_{34} = S_{56} = .131 \triangleq .131$, $W_3 = W_6 = .092$

$S_{45} = .1325 \triangleq .133$, $W_4 = W_5 = .093$

FOR END CAPACITY:

$$\frac{1}{2}C = \frac{.225\,\epsilon_r A}{.010}$$

$$A = \frac{(.010)(1.27/2)}{(.225)(2.1)} = .0269 \text{ in}^2$$

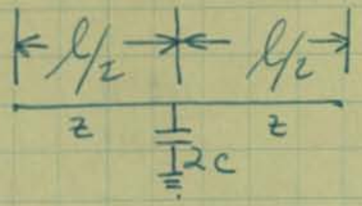


$$x\,.090 = \frac{.0269}{2}, \quad x = \frac{.0269/2}{.090} = 0.135 \qquad 0.3/2 = .150$$

$$\boxed{\text{LET } x \triangleq .125}$$

$$l_0 = \frac{1}{12}\,\frac{3\times10^{10}}{2.95\times10^{9}}\,2.54 = .332$$

3/26/64 INPUT LOW PASS FILTER FOR X-BAND SOURCE.



$$Z_I = \pm\sqrt{\frac{B}{C}} = \pm Z\sqrt{\frac{1 - m\phi\tan\phi/2}{1 + m\phi\cot\phi/2}}$$

TRY $f_1 = 5.0$ Kmc. $f_2 = 20.0$ Kmc. u $180° = \phi_2$

$\therefore f_1$ u $\phi_1 = 45°$, 4.5 Kmc u $\phi_{4.5} = 40.5°$

SINCE $A = \cos\phi - m\phi\sin\phi$

{ AT CUTOFF $-1 = \cos 45° - m\frac{\pi}{4}\sin 45°$

$-1 = .707 - m\frac{\pi}{4}(.707)$

$m = \frac{(1.707)4}{.707\pi}$, $\boxed{m = 3.07}$

FOR THIS CASE: $\frac{Z_I}{Z} = \sqrt{\frac{1 - 3.07\phi\tan\phi/2}{1 + 3.07\phi\cot\phi/2}}$

.01745 rad = 1°

f(kmc)	$\phi°$	$\frac{\phi}{2}°$	ϕ rad.	$\tan\frac{\phi}{2}$	$\cot\frac{\phi}{2}$	X $3.07\phi\tan\phi/2$	Y $3.07\phi\cot\phi/2$	1-X	1+Y	$\frac{1-X}{1+Y}$	$\sqrt{\frac{1-X}{1+Y}}$
3.34	30°	15	.524	.268	3.732	.432	6.00	.568	7.00	.081	.28
4.5	40.5°	20.25	.706	.369	2.710	.800	5.88	.200	6.88	.029	.17
5.0	45°	22.50	.785	.414	2.414	1.000	5.82	0	6.82	0	0
5.55	50°	25.0	.872	.466	2.145	1.250	5.75	-.250	6.75	-.037	j.19
6.67	60°	30.0	1.050	.577	1.732	1.860	5.59	-.860	6.59	-.130	j.36
9.00	81°	40.5	1.415	.854	1.171	3.71	5.10	-2.71	6.10	-.444	j.67
10.00	90°	45.	1.570	1.000	1.000	4.82	4.82	-3.82	5.82	-.655	j.81
13.500	121.5°	60.75	2.120	1.785	.560	11.60	3.64	-10.60	4.14	-2.28	j1.51
18.00	162.0°	81.00	2.825	6.314	.158	54.80	1.37	-53.8	2.37	-22.7.	j4.77

3/30/64 CONT. FROM p. 141

f (kmc)	$\phi°$	$Z_1 = Z_2 = 67\Omega$ Rot. $\phi/2$
3.34	30	18.8
4.50	40.5	11.4 ~~14~~.0
5.00	45	0
5.55	50	j 12.7
6.67	60	j 24.1
9.00	81	j 45.0
10.00	90	j 54.2
13.50	121.5	j 101.0
18.00	162.0	j 319.0

FOR MATCHING 11.4Ω AT 4.5 kmc TO 50Ω.

TRY 1 STEP TRANSFORMER Z_m

$$Z_m = \sqrt{(11.4)(50)} = 5\sqrt{22.8} = (5)(4.78)$$

$$Z_m = 23.9\,\Omega.$$

IN AIR $\frac{23.9}{138} = .173 = \log \frac{D}{d}$

$$\frac{D}{d} = 1.485, \quad d = \frac{.25}{1.485} = \underline{.169}$$

4/1/64   5% BANDWIDTH   C BAND FILTER

$f_1 = 5.830$ Kmc. $f_2 = 6.220$ Kmc

$f_0 = 6.025$ Kmc

$$\begin{array}{r} 6.220 \\ 5.830 \\ \hline 2\,)\,12.050 \\ 6.025 \end{array}$$

TRY $n = 7$ RESONATORS

$$W = \frac{.390}{6.025} = .065$$

$$\begin{array}{r} 6.220 \\ 5.830 \\ \hline .390 \end{array}$$

WITH $g_0 = 1$, $\omega_1' = 1$

$g_1 = 1.1811$, $g_2 = 1.4228$, $g_3 = 2.0966$, $g_4 = 1.5733$, $g_5 = 2.0966$, $g_6 = 1.4228$

$g_7 = 1.1811$, $g_8 = 1.0000$.

$$\theta_1 = \frac{\pi}{2}\left(1 - \frac{W}{2}\right) = (1.57)(.9676)$$

$$\begin{array}{r} 1.0000 \\ .0324 \\ \hline .9676 \end{array}$$

$$\underbrace{\theta_1 = 1.52}\ \text{RAD.}$$

$$\frac{J_{01}}{Y_A} = \frac{1}{\sqrt{g_0 g_1 \omega_1'}} = \frac{1}{\sqrt{1 \cdot 1.1811}} = \frac{1}{1.09} = \underbrace{.918}$$

ALSO $\frac{J_{78}}{Y_A} = \underbrace{.918}$

$$\frac{J_{12}}{Y_A} = \frac{J_{67}}{Y_A} = \frac{1}{\sqrt{(1.1811)(1.4228)}} = \frac{1}{\sqrt{1.68}} = \underbrace{.770}$$

$$\frac{J_{23}}{Y_A} = \frac{J_{56}}{Y_A} = \frac{1}{\sqrt{(1.4228)(2.0966)}} = \frac{1}{\sqrt{2.98}} = \underbrace{.578}$$

$$\frac{J_{34}}{Y_A} = \frac{J_{45}}{Y_A} = \frac{1}{\sqrt{(2.0966)(1.5733)}} = \frac{1}{\sqrt{3.30}} = \underbrace{.550}$$

$$\left(\frac{J_{01}}{Y_A}\right)^2 = .842 \quad \left(\frac{J_{12}}{Y_A}\right)^2 = .593 \quad \left(\frac{J_{23}}{Y_A}\right)^2 = .334 \quad \left(\frac{J_{34}}{Y_A}\right)^2 = .302$$

$$\theta_1 = 1.52\ \frac{180}{\pi} = 87^\circ, \quad \tan\theta_1 = 19.08$$

$$\frac{\tan^2\theta_1}{4} = \underbrace{91.0} \qquad \frac{\tan\theta_1}{2} = 9.54$$

4/2/64 CONT. FROM p. 142

$$N_{12} = \sqrt{\left(\frac{J_{12}}{Y_A}\right)^2 + \frac{\tan^2\theta}{4}} = \sqrt{\cancel{.770}\ .593 + 91.0}$$

$$\underline{N_{12} = 9.57 = N_{67}}$$

$$N_{23} = \sqrt{\left(\frac{J_{23}}{Y_A}\right)^2 + \frac{\tan^2\theta}{4}} = \sqrt{.334 + 91}$$

$$N_{23} = 9.56 \quad , \quad N_{34} = 9.56$$

$$\underline{N_{56} =} \qquad \underline{N_{45} =}$$

CALCULATE h FROM p. 120

$$h = \frac{5.4}{\frac{376.7}{\sqrt{\epsilon_r}} Y_A \left[\frac{J_{23}}{Y_A} + \frac{J_{32}}{Y_A} + N_{23} + N_{34}\right]}$$

$$h = \frac{5.4}{7.53\,(.578 + .550 + 9.56 + 9.56)}$$

$$h = \frac{5.4}{(7.53)(20.25)} = .0354$$

$$\begin{array}{r} 9.56 \\ \underline{2} \\ 19.12 \\ .58 \\ \underline{.55} \\ 20.25 \end{array}$$

$$\underline{h \simeq .035} \qquad \sqrt{h} = .187$$

$$M_1 = M_7 = Y_A\left[\frac{J_{01}}{Y_A}\sqrt{h} + 1\right] = .02\left[\underset{.172}{(.918)(.187)} + 1\right]$$

$$= (.02)(1.172)$$

$$\underline{M_1 = M_7 = .0234}$$

$$\frac{C_0}{\epsilon} = \frac{C_8}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}}\left[2Y_A - M_1\right] = 376.7\left[.04 - .0234\right]$$

$$\boxed{\frac{C_0}{\epsilon} = 6.25}$$

$$\begin{array}{r} .0400 \\ \underline{.0234} \\ .0166 \end{array}$$

4/3/64 CONT. FROM P. 143.

$$\frac{C_1}{\epsilon} = \frac{C_7}{\epsilon} = \frac{376.7}{\sqrt{\varepsilon_r}}\left\{ Y_A - M_1 + h Y_A \left[\frac{\tan\theta_1}{2} + \left(\frac{J_{01}}{Y_A}\right)^2 + N_{12} - \frac{J_{12}}{Y_A} \right] \right\}$$

$$= 376.7 \left\{ .02 - .0234 + (.035)(.02)\left[9.54 + .842 + 9.57 - .770 \right] \right\}$$

$$= 376.7 \left[-.0034 + \underbrace{(.0007)(19.18)}_{.0127} \right],$$

$$\begin{array}{r} .0127 \\ -.0034 \\ \hline .0093 \end{array} \qquad \begin{array}{r} 9.54 \\ .84 \\ 9.57 \\ \hline 19.95 \\ 0.77 \\ \hline 19.18 \end{array}$$

$$\frac{C_1}{\epsilon} = (376.7)(.0093)$$

$$\boxed{\frac{C_1}{\epsilon} = \frac{C_7}{\epsilon} = 3.50}$$

$$\frac{C_2}{\epsilon} = \frac{C_6}{\epsilon} = \frac{376.7}{\sqrt{\varepsilon_r}} h Y_A \left[N_{1,2} + N_{2,3} - \frac{J_{1,2}}{Y_A} - \frac{J_{2,3}}{Y_A} \right]$$

$$\frac{376.7}{\sqrt{\varepsilon_r}} h Y_A = (376.7)(.035)(.02) = 0.264$$

$$\frac{C_2}{\epsilon} = 0.264\,\underbrace{(9.57 + 9.56 - .770 - .58)}_{17.78},$$

$$\begin{array}{r} .77 \\ .58 \\ \hline 1.35 \end{array} \qquad \begin{array}{r} 9.57 \\ 9.56 \\ \hline 19.13 \\ -1.35 \\ \hline 17.78 \end{array}$$

$$\boxed{\frac{C_2}{\epsilon} = 4.70 = \frac{C_6}{\epsilon}}$$

$$\frac{C_3}{\epsilon} = \frac{C_5}{\epsilon} = (.264)\left[N_{2,3} + N_{3,4} - \frac{J_{2,3}}{Y_A} - \frac{J_{3,4}}{Y_A} \right]$$

$$= (.264)(9.56 + 9.56 - .58 - .55)$$

$$\begin{array}{r} 9.56 \\ 2 \\ \hline 19.12 \\ -1.13 \\ \hline 17.99 \end{array}$$

$$\boxed{\frac{C_3}{\epsilon} = \frac{C_5}{\epsilon} = 4.75}$$

$$\frac{C_4}{\epsilon} = .264\left[N_{3,4} + N_{4,5} - \frac{J_{3,4}}{Y_A} - \frac{J_{4,5}}{Y_A} \right]$$

$$= .264(9.56 + 9.56 - .550 - .550)$$

$$\begin{array}{r} 19.12 \\ -1.10 \\ \hline 18.02 \end{array}$$

$$\boxed{\frac{C_4}{\epsilon} = 4.75}$$

4/3/64 CONT. FROM p. 144

$$\frac{C_{01}}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}}\left[M_1 - Y_A\right] = 376.7(\underset{.0034}{.0234 - .02})$$

$$\frac{S_{01}}{b}$$

$$\boxed{\frac{C_{01}}{\epsilon} = \frac{C_{78}}{\epsilon} = 1.28}$$

$$\frac{C_{12}}{\epsilon} = \frac{C_{67}}{\epsilon} = \frac{376.7\,h}{\sqrt{\epsilon_r}}\,Y_A \cdot \left(\frac{J_{12}}{\epsilon}\right)$$

$$= (.264)(.770)$$

$$\boxed{\frac{C_{12}}{\epsilon} = \frac{C_{67}}{\epsilon} = .203}$$

$$\frac{C_{23}}{\epsilon} = \frac{C_{56}}{\epsilon} = (.264)\left(\frac{J_{23}}{\epsilon}\right) = (.264)(.580)$$

$$\boxed{\frac{C_{23}}{\epsilon} = \frac{C_{56}}{\epsilon} = .153}$$

$$\frac{C_{34}}{\epsilon} = \frac{C_{45}}{\epsilon} = (.264)\left(\frac{J_{34}}{\epsilon}\right) = (.264)(.550)$$

$$\boxed{\frac{C_{34}}{\epsilon} = \frac{C_{45}}{\epsilon} = .145}$$

USING $\frac{t}{b} = .25$, $t = \frac{1}{16}$, $b = \frac{1}{4}$

$\frac{S_{01}}{b} = .28$, $\underbrace{S_{01} = .070}$, $\left(\frac{C'_{fe}}{\epsilon}\right)_{01} = .325$

$\frac{S_{12}}{b} = .815$, $\underbrace{S_{12} = .204}$ $\left(\frac{C'_{fe}}{\epsilon}\right)_{12} = .640$

$\frac{S_{23}}{b} = .910$, $\underbrace{S_{23} = .227}$ $\left(\frac{C'_{fe}}{\epsilon}\right)_{23} = .660$

$\frac{S_{34}}{b} = .925$, $\underbrace{S_{34} = .231}$ $\left(\frac{C'_{fe}}{\epsilon}\right)_{34} = .660$

$\frac{1}{2}\left(1 - \frac{t}{b}\right) = .375$

$\frac{C'_f}{\epsilon} = .745$

$$\frac{w_0}{b} = \frac{w_8}{b} = \frac{1}{2}\left(1 - \frac{t}{b}\right)\left[\frac{1}{2}\left(\frac{C_0}{\epsilon}\right) - \frac{C'_f}{\epsilon} - \left(\frac{C'_{fe}}{\epsilon}\right)_{01}\right] = (.375)\left[\frac{6.25}{2} - .745 - .325\right]$$

$$\begin{array}{r} 3.125 \\ -1.070 \\ \hline 2.055 \end{array} \qquad \begin{array}{r} .745 \\ .325 \\ \hline -1.070 \end{array}$$

$\frac{w_0}{b} = \frac{w_8}{b} = 0.770$, $\underbrace{w_0 = w_8 = 0.192}$

4/6/64 Cont. From p. 145

$$\frac{W_k}{b} = \frac{1}{2}\left(1-\frac{t}{b}\right)\left[\frac{1}{2}\left(\frac{C_k}{\epsilon}\right) - \frac{(C_{fe}')_{k-1,k}}{\epsilon} - \frac{(C_{fe}')_{k,k+1}}{\epsilon}\right]$$

C_1/ϵ $\quad (C_{fe}')_{0,1}$ $\quad (C_{fe}')_{12}$

$$\frac{W_1}{b} = .375\left[\frac{3.50}{2} - .325 - .640\right], \qquad \begin{array}{r} 1.750 \\ -\ .965 \\ \hline .785 \end{array} \qquad \begin{array}{r} -.640 \\ -.325 \\ \hline -.965 \end{array}$$

1.75

$\frac{W_1}{b} =$ ~~.656~~ .294 , $w_1 =$ ~~.164~~ .076

$$\frac{W_2}{b} = .375\left[\frac{4.70}{2} - .640 - .660\right] \qquad \begin{array}{r} 2.35 \\ -1.30 \\ \hline 1.05 \end{array} \qquad \begin{array}{r} -.660 \\ -.640 \\ \hline -1.300 \end{array}$$

2.35

$\frac{W_2}{b} = .394$, $W_2 = .098$

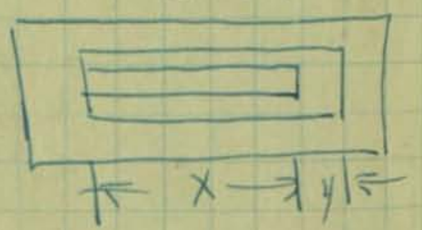
$$\frac{W_3}{b} = .375\left[\frac{4.75}{2} - .660 - .660\right] \qquad \begin{array}{r} 2.37 \\ -1.32 \\ \hline 1.05 \end{array} \qquad \begin{array}{r} .660 \\ 2 \\ \hline -1.320 \end{array}$$

~~2.35~~ 2.37

$\frac{W_3}{b} = .386$, $W_3 =$ ~~.096~~ .098

$\frac{W_4}{b} = .375\left[4.75 - .660 - .660\right]$, $W_4 =$ ~~.096~~ .098

For 5.9 - 6.4



$x + y = .510$

$x = .427$

$f_0 = 6.15$

$S_{01} = S_{78} = .070$

$S_{12} = S_{67} = .204$

$S_{23} = S_{56} = .227$

$S_{34} = S_{45} = .231$

$W_1 =$ ~~.164~~ .076

$W_2 = .098$

$W_3 =$ ~~.096~~ .098

$W_4 =$ ~~.096~~ .098

$\frac{6.15}{6.025} = \frac{.427}{x'}$, $x' = .418$

$\frac{6.15}{6.025} = \frac{.083}{y'}$, $y' = .081$

$x' + y' = .499 \cong .500$

4/15/64 X - BAND W. G. FILTER

$f_1 = 9.0$ kmc, $f_2 = 9.6$ kmc, 2 SECTION. $n=2$

IN THIS CASE WILL USE INDUCTIVE POSTS.

FOR AN .01db RESPONSE:

1 : .449 : .408 : 1.101

$$\Omega = \pi\left[\frac{\lambda_{g1}-\lambda_{g2}}{\lambda_{g1}+\lambda_{g2}}\right]$$

, $\lambda_{g1} = 1.9144''$

$\lambda_{g2} = 1.6831''$

$\lambda_{g1}+\lambda_{g2} = 3.5975$

$\lambda_{g1}-\lambda_{g2} = .2313$

$$\Omega = 3.14\left(\frac{.231}{3.598}\right)$$

$\boxed{\Omega = .202}$ $\boxed{\Omega^2 = .041}$

$$X_{01} = \frac{\Omega/\sqrt{g_0 g_1}}{1-\frac{\Omega^2}{g_0 g_1}} = \frac{.202/\sqrt{.449}}{1-\frac{.041}{.449}} = \frac{.301}{.909}$$

$\frac{.202}{.671}$

.0905

$$\begin{array}{r} 1.000 \\ -.091 \\ \hline .909 \end{array}$$

$\boxed{X_{01} = .331}$ .184

$$X_{12} = \frac{.202/\sqrt{(.449)(.408)}}{1-\frac{.041}{(.449)(.408)}} = \frac{.2.02/.429}{1-.224} = \frac{.4.71}{.776}$$

$$\begin{array}{r} 1.000 \\ .224 \\ \hline .776 \end{array}$$

$\boxed{X_{12} = .606}$, $\boxed{X_{23} = .331}$ ← SYMMETRY

$$\phi_k = 180^\circ - \frac{1}{2}\left[\tan^{-1}(2X_{k-1,k}) + \tan^{-1}(2X_{k,k+1})\right]$$

$\tan^{-1}(2X_{01}) = \tan^{-1} .662 = 33.5^\circ$ $\frac{84}{2} = 42$

$\tan^{-1}(2X_{12}) = \tan^{-1} 1.212 = 50.5^\circ$

$\phi_2 = \phi_1 = 180^\circ - 42^\circ = 138^\circ$

$$\begin{array}{r} 180 \\ 42 \\ \hline 138 \end{array}$$

$l = \frac{138}{360}\lambda_{g\,9.3\text{kmc}} = \frac{138}{360}(1.790) = .686$

CONT. FROM p. 147 4/15/64

$X_{01} = .331 = X_{23}$

$X_{12} = .606$

$\frac{\lambda_{\cancel{g}0}}{a} = \frac{1.27}{.9} = \underline{1.41}$

$\lambda_0 = \frac{3 \times 10^{10}}{9.3 \times 10^9 \; 2.54} = 1.27''$

$Z_0 @ 9.3 kmc = (377) \frac{\pi}{2} \; \frac{.4}{.9} \; 1.41$

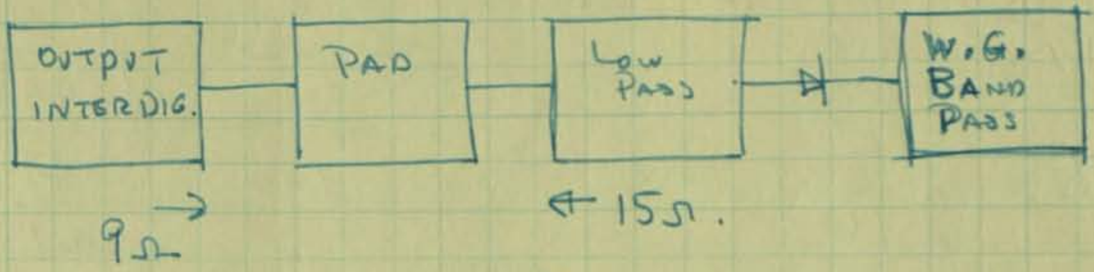
$\underline{Z_0 @ 9.3 = 371 \Omega.}$

$\cancel{X}$

$\frac{X_{01}}{Z_0} \frac{\lambda_g}{2a} = \frac{.331}{371} \; \frac{1.790}{(2)(.9)} = .0089 \simeq .01$

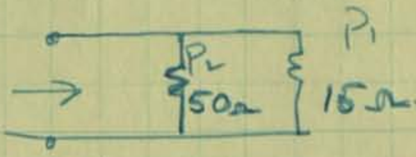
TOO SMALL - OFF CHARTS

4/28/64 X-BAND SOURCE



$P_0 \rightarrow R \rightarrow$

$= 1$



$, \; R = \frac{15 \cdot 50}{15 + 50} = \frac{750}{65}$

$R = 11.5 \Omega$

$\frac{P_1}{P_2} = \frac{50}{15} = 3.33 \; , \; \frac{P_2}{P_1} = .3 \; , \; P_2 = .3 P_1$

$P_1 + .3 P_1 = 1 \; , \; P_1 = \frac{1}{1.3} = .77$

$\frac{P_1}{P_0} = .77 \; , \; \sqrt{\frac{P_1}{P_0}} = .88$

EQUIV. TO ABOUT 1.1 db PAD.

5/15/64 X-BAND MULT.
7th

$$7 \,\underline{\big|\, 9.0 - 9.6}$$
$$1.29 - 1.37$$

$f_{o_1} = 1.29$ kmc, $f_{o_2} = 1.37$ kmc.

CONSIDER 8th HARMONIC OF 1.29 kmc

$f_8 = 10.3$ kmc, $f_6^{(1)} = 8.22$

$$W' = \frac{2w_1'}{W}\left|\frac{w - w_0}{w_0}\right|,$$

$f_0 = 9.3$ kmc.

$$\frac{f - f_0}{f_0} = \frac{10.3 - 9.3}{9.3} = \frac{1}{9.3}$$

$$= .107$$

or ~~$\left|\frac{8.22 - 9.3}{9.3}\right| = \frac{.78}{9.3}$~~ =

$$\xrightarrow{} f = \frac{f_2 - f_1}{f_0} = \frac{.600}{9.3} = .0645$$

$$W' = \frac{2}{.0645}(.107) = 3.32$$

FOR .1db RIPPLE $\left|\frac{w'}{w_1'}\right| - 1 = 2.32$

CONSIDER 6th

$$6 \,\underline{\big|\, 9.0 - 9.6}$$
$$1.5 - 1.6$$

LOOK AT $7 \times 1.5 = 10.5$

$$\frac{f - f_0}{f_0} = \frac{10.5 - 9.3}{9.3} = \frac{1.2}{9.3} = .129$$

$$\frac{f_2 - f_1}{f_0} = .0645$$

$$\frac{w'}{w_1'} = \frac{2}{(.0645)}(.129) = 4.0$$

$$\left|\frac{w'}{w_1'}\right| - 1 = 3.0$$

5 RESONATORS SHOULD GIVE 67 db.

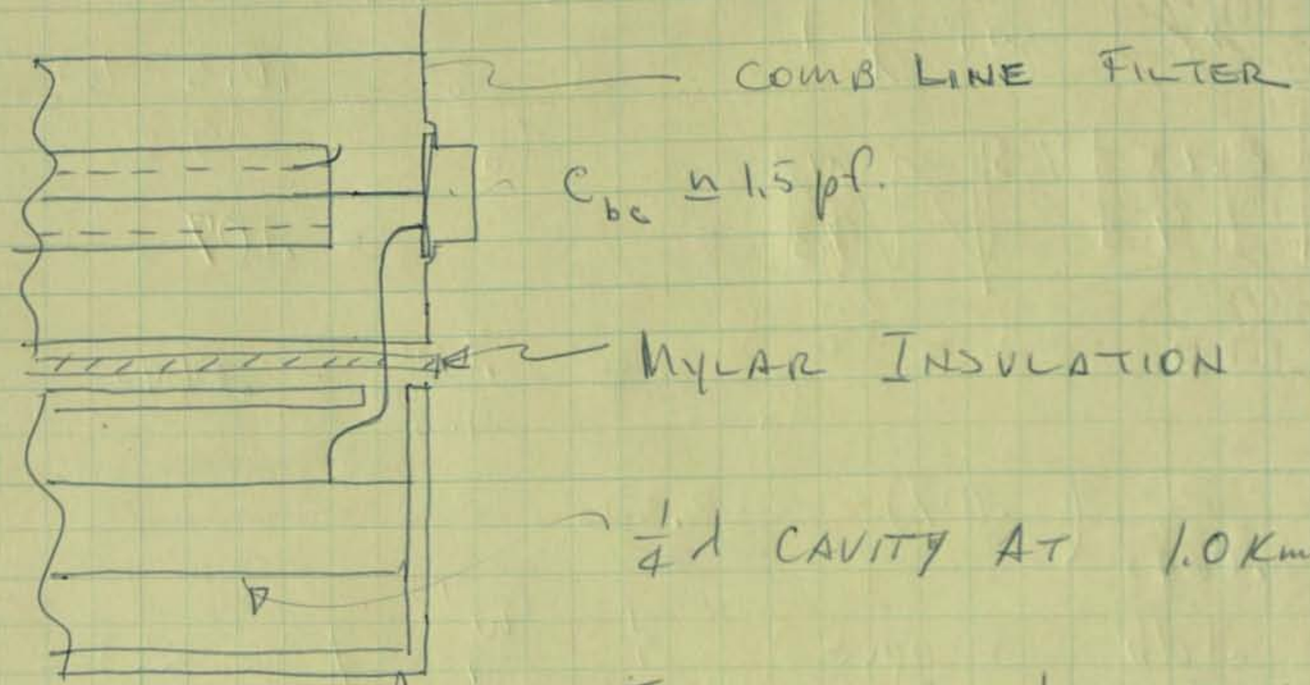
~~CONT. FROM p. 149~~ 5/20/64

5.4 - 5.9 Kmc SOURCE STRAIGHT FROM TRANSISTOR.

ASSUME USING 6th HARMONIC ∴

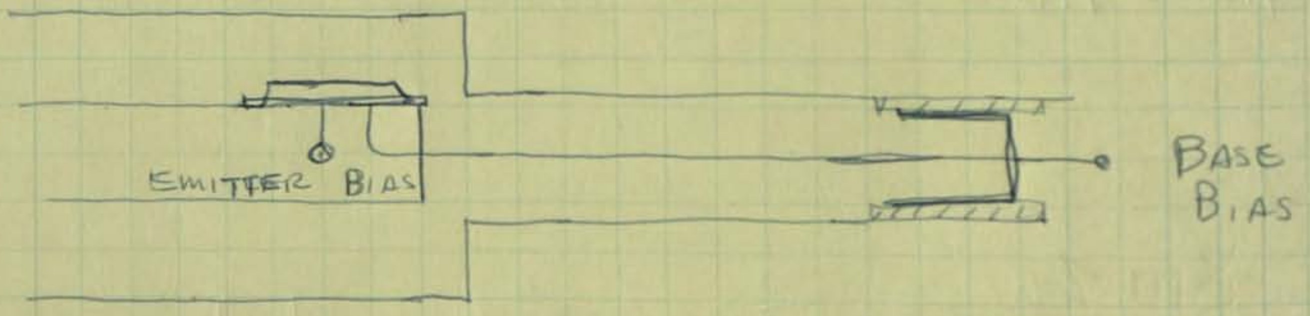
FUNDAMENTAL WILL BE .9 - 1.0 Kmc.

CONSIDER A COMB LINE OUTPUT FILTER



ABOVE TRANSISTOR LOCATION SHOULD WORK FOR ODD HARMONICS.

FOR EVEN!



CONSIDER APPROPRIATE COMB LINE DESIGN - ~~FROM p. 131 $C_j^s = 2.7$ pf.~~

~~FOR $\Theta_0 = 30°$~~

5/21/64 CONT. FROM p. 150

$$C_j^s = Y_A \left(\frac{Y_{aj}}{Y_A}\right) \frac{\cot \theta_0}{\omega_0}$$

IF $Y_{aj} = \frac{1}{70}$ $\quad C_j^s = \frac{1}{(70)\, 2\pi\ 5.65 \times 10^9} = .4\,pf.$

$\boxed{\text{TRY} \quad \theta_0 = 30^\circ}$ $\Big\{$ $Y_{aj} = \frac{1}{50}$

$$C_j^s = \frac{1.732}{50\ 2\pi\ 5.65 \times 10^9} = .98\,pf \quad \text{TOO SMALL!}$$

OR $\quad Y_{aj} = \frac{1}{25}$, $\quad \boxed{C_j^s = 1.95\,pf.}$

$\theta_0 = \frac{\pi}{\cancel{180}_{6}} \cancel{30} =$

$\therefore \frac{Y_{aj}}{Y_A} = 2.0$, SINCE $Y_A = 50\Omega.$

$$\therefore \frac{b_j}{Y_A} = \cancel{2}.\left(\frac{\cot 30^\circ + \theta_0 \csc^2 30^\circ}{\cancel{2}}\right) = 1.732 + (.523)(2)^2$$

$$\begin{array}{r} 2.092 \\ 1.732 \\ \hline 3.824 \end{array}$$

$$\frac{b_j}{Y_A} = 3.824$$

LET $f_1 = 5.350$ kmc., $f_2 = 5.950$ kmc.

$$W = \frac{f_2 - f_1}{f_0} = \frac{600}{5650} = .106$$

[illegible] LET $n=5$ $\quad$ .1 db RIPPLE.

1.000: 1.1468 : 1.3712 : 1.9750 : 1.3712 : 1.1468 : 1.000

$g_0 \quad g_1 \quad g_2 \quad g_3 \quad g_4 \quad g_5 \quad g_6$

$$\frac{G_{T1}}{Y_A} = \frac{w\ b_1/Y_A}{g_0 g_1 \omega_1'} = \frac{(.106)(3.824)}{1.147} = \underset{\sim\sim}{.354}$$

$$\frac{J_{1,2}}{Y_A} = \frac{(.106)(3.824)}{\sqrt{(1.147)(1.371)}} = \frac{.406}{\sqrt{1.57}} = \frac{.406}{1.25} = \underset{\sim\sim}{.324}$$

$$\frac{J_{23}}{Y_A} = \frac{(.106)(3.824)}{\sqrt{(1.371)(1.975)}} = \frac{.406}{\sqrt{2.71}} = \frac{.406}{1.65} = \underset{\sim\sim}{.246}$$

152 5/21/64 CONT. FROM p. 151

$$\frac{C_0}{\epsilon} = \frac{316.7\,Y_A}{\sqrt{\epsilon_r}}\left(1 - \sqrt{\frac{G_{T_1}}{Y_A}}\right) = 7.53\left(1 - \sqrt{\cancel{(.354)(50)}}\right)$$

$1 - .595$

$.354$

$\cancel{17.7}$

$$\begin{array}{r} 1.000 \\ .595 \\ \hline .405 \end{array}$$

$$\boxed{\frac{C_0}{\epsilon} = 3.05}$$

$$\frac{C_1}{\epsilon} = 7.53\left(2 - 1 + .354 - \overset{.181}{.324 \tan 30^\circ}\right) + 3.05$$

$\frac{1}{1.732}$

$$= 7.75 + 3.05$$

$$\begin{array}{r} 2.354 \\ -\ 1.324 \\ \hline 1.030 \end{array}$$

$$\boxed{\frac{C_1}{\epsilon} = 10.8}$$

$$\frac{C_2}{\epsilon} = 7.53\left(2 - \frac{J_{12}}{Y_A}\tan 30^\circ - \frac{J_{23}}{Y_A}\tan 30^\circ\right)$$

$$= 7.53\left(2 - .181 - \frac{.246}{1.732}\right)$$

$.142$

$$\begin{array}{r} 2.000 \\ .323 \\ \hline 1.677 \end{array} \qquad \begin{array}{r} .181 \\ .142 \\ \hline .323 \end{array}$$

$$\boxed{\frac{C_2}{\epsilon} = 12.6}$$

$$\frac{C_3}{\epsilon} = 7.53\left(2 - .142 - \underbrace{\frac{J_{34}}{Y_A}\tan 30^\circ}_{.142}\right)$$

$$\begin{array}{r} 2.000 \\ .284 \\ \hline 1.716 \end{array}$$

$$\boxed{\frac{C_3}{\epsilon} = 12.9}$$

$$\boxed{\frac{C_{01}}{\epsilon} = 7.53 - 3.05 = 4.48}$$

$$\begin{array}{r} 7.53 \\ 3.05 \\ \hline 4.48 \end{array}$$

$$\boxed{\frac{C_{12}}{\epsilon} = 7.53\,(.181) = 1.36}$$

$$\boxed{\frac{C_{23}}{\epsilon} = 7.53\,(.142) = 1.08}$$

TRY $\frac{t}{b} = \cancel{.6}\,;\ .4$

$b = \frac{1}{4}$, $t = \cancel{.150}\ .100$

$\frac{C_{01}}{\epsilon} = 4.48$, $\frac{s_{01}}{b} = \cancel{.145}\ .110$, $\left(\frac{C'_{fe}}{\epsilon}\right)_{01} = \cancel{.32}\ .17$, $s_{01} = \cancel{.036}\ .028$

$\frac{C_{12}}{\epsilon} = 1.36$, $\frac{s_{12}}{b} = \cancel{.290}\ .330$, $\left(\frac{C'_{fe}}{\epsilon}\right)_{12} = \cancel{.70}\ .44$, $s_{12} = \cancel{.098}\ .083$

$\frac{C_{23}}{\epsilon} = 1.08$, $\frac{s_{23}}{b} = \cancel{.455}\ .390$, $\left(\frac{C'_{fc}}{\epsilon}\right)_{23} = \cancel{.98}\ .51$, $s_{23} = \cancel{.114}\ .095$

①

~~EL 12, 90~~

Suppose $C_1^t = .5\,pf.$ LET $G_A = \frac{1}{35}$

ASSUME $C_{01} = 3.0\,pf.$

$\omega_0 = 6.21 \times 10^9$

$$\omega_0 C_{01} = (6.21 \times 10^9)(3.0 \times 10^{-12}) = 18.63 \times 10^{-3}$$

$$\frac{\omega_0 C_{01}}{G_A} = (18.63 \times 10^{-3})(\overset{}{\underset{25}{35}}) = 652 \times 10^{-3} = \underbrace{.652}_{.466}$$

$$\left(\frac{\omega_0 C_{01}}{G_A}\right)^2 = \underbrace{.425}_{.217}$$

$$\frac{\omega_0 C_{01}}{1 + \left(\frac{\omega_0 C_{01}}{G_A}\right)^2} = \frac{18.63 \times 10^{-3}}{\underset{1.217}{1.425}} = \overset{.015}{\underbrace{13.1 \times 10^{-3}}_{.013}}$$

$$\omega_0 C_1^t = (6.21 \times 10^9)(.5 \times 10^{-12}) = \underbrace{3.11 \times 10^{-3}}_{.003}$$

LET $C_{12} = 1\,pf.$

$$\omega_0 C_{12} = 6.21 \times 10^9 \times 10^{-12} = \underbrace{.006}$$

$$B_1^J = \overset{.015}{.013} + .003 + .006 = \overset{.024}{\underbrace{.022}}$$

$$\frac{B_1^J}{Y_0} = \frac{\overset{.024}{.022}}{.02} = \underbrace{1.1}_{1.75}\quad 1.2$$

$$\frac{b_1}{Y_0} = 1.65, \quad b_1 = (\overset{1.75}{1.65})(.02) = \overset{.0350}{\underbrace{.0330}}\ \overset{.016}{}$$

$$J_{01} = \sqrt{\frac{G_A b_1 W}{g_0 g_1 \omega_1'}} = \sqrt{\frac{(\overset{.035}{.033})(.20)}{(\overset{25}{35})(1.109)}} = \sqrt{\overset{.00025}{.00017}} = \overset{.016}{\underbrace{\overset{.013}{\sqrt{.041}}}}$$

$\frac{Q_1}{TO\,4} = .560$

PAGCO.

$(.016)(25) = .40 \qquad (J_{01}/G_A) = .16$

$$\frac{J_{01}}{G_A} = (\underline{.013})(35) = .457, \quad \left(\frac{J_{01}}{G_A}\right)^2 = .209$$

$$\frac{J_{01}}{\sqrt{1-\left(\frac{J_{01}}{G_A}\right)^2}} = \frac{\overset{.016}{.013}}{\underset{.915}{.89}} = \underset{.0175}{.0147}$$

$$\begin{array}{r} 1.000 \\ .16 \\ \hline .84 \end{array} \qquad \begin{array}{r} 1.000 \\ .209 \\ \hline .791 \end{array}$$

$\therefore \; \omega_0 C_{01} = .0147$

$$C_{01} = \frac{.0147 \; .0175}{6.21 \times 10^9}$$

$\sqrt{.791} = .89$

$\sqrt{.84} = .915$

$C_{01} = 2.37 \text{ pf.}$ $\boxed{2.82 \text{ pf}}$

~~CONSIDER $G_A = \frac{1}{25}$, $C_{01} = 2.40$~~

~~$\frac{\omega_0 C_{01}}{G_A} = (1.555 \times 10^{-1})(3) = .424$~~

To CALCULATE C_{12}

USING $B_J^J\Big|_{j=2 \text{ to } n-1} = \omega_0 C_{j-1,j} + \omega_0 C_j^{+} + \omega_0 C_{j,j+1}$

$B_2^J = \omega_0 (C_{12} + .5\text{pf} + C_{23})$

ESTIMATING $C_{12} = 1.0\text{pf.}$, $C_{23} = 1.0\text{ pf.}$

USING $5\omega_0$ RESONATOR

$B_2^J = (6.21 \times 10^9)(2.5 \tfrac{8}{2} \times 10^{-12}) = 15.5 \times 10^{-3}$

$= 1.55 \times 10^{-2}$

$\frac{B_2^J}{Y_0} = (1.55 \times 10^{-2})(25) = 38.8 \times 10^{-2} = \underset{.775}{.388}$

$l_2 \approx .630 \; \lambda_0/4$

$\frac{b_2}{Y_0} = \underset{1.25}{1.02}$, $b_2 = \frac{(1.02)(\overset{1.25}{~~1.25~~})}{25 \;\; 50} = .025$

$b_2 =$ ~~[illegible]~~ $\underset{.0204}{.0408}$

$$J_{12} = .20\sqrt{\frac{b_1 b_2}{g_1 g_2}} = .20\sqrt{\frac{(\overset{.835}{\cancel{.876}})(\overset{.025}{\cancel{.041}})}{(1.109)(1.306)}}$$

$$= .20\sqrt{\frac{\overset{5.91}{\cancel{4.53\times10^{-4}}}}{9.92\times10^{-4}}}$$

$$\frac{\overset{2}{\cancel{3}}\cancel{1.6} \cdot 4 \times 10^{-4}}{1.6}$$

$$= (.20)\,\underset{3.15}{(\cancel{2.13})}\times10^{-2} = \overset{.630}{\cancel{.426}}\times10^{-2}$$

$$\cancel{2.44} \qquad .488$$

$$J_{12} \simeq \cancel{.004}\ \underline{.006}$$

$$\cancel{\frac{J_{12}}{\cancel{Y_0}G_A} = (.006)(25) = \cancel{.210}\,.150,\ \left(\frac{J_{12}}{G_A}\right)^2 = .0225}$$

$$\begin{array}{r} 1.0000 \\ -\ .0225 \\ \hline .9775 \end{array}$$

$$\omega_0 C_{12} = J_{12}$$

$$\boxed{C_{12} = \frac{\overset{.00488}{\cancel{.006}}}{6.21\times10^{9}} = \overset{}{\cancel{0.97}}\ \underset{.79}{}\ pf.}$$

TO CALCULATE $\underline{C_{23}}$

USING 5ω_0 RESONATOR

$$B_3^J = \omega_0\,(C_{23} + \cancel{2}.5pf. + C_{34})$$

ESTIMATE $C_{23} = \overset{.75}{\cancel{1.0}}pf.$ } $C_{34} = \overset{.75}{\cancel{1.0}}pf.$

$$\therefore B_3^J = (6.21\times10^{9})(2.\cancel{0}\times10^{-12}) = 12.42\times10^{-\cancel{5}\,5}$$

$$\cancel{\left(\frac{B_3^{B}}{Y_0}\right)^2 = \cancel{.388}}\ \}\ \frac{b_2}{Y_0} = \cancel{1.02}\ \frac{.01242}{.020} = .621$$

$$\}\ \cancel{b_2} =$$

$$\frac{l_3}{\frac{\lambda_0}{4}} = .530$$

$$\frac{B^J_3}{Y_0} = .621 \quad , \quad \frac{b_3}{Y_0} = 1.17, \quad b_3 = \frac{(1.17)}{.50} = .0234$$

$$J_{23} = W\sqrt{\frac{b_2 b_3}{g_2 g_3}} = .2\sqrt{\frac{(.025)(.023)}{(1.306)(1.770)}}$$

$$= .2\sqrt{2.49 \times 10^{-4}} = (.2)\ 1.58 \times 10^{-2}$$

$$J_{\cancel{44}\,23} = .316 \times 10^{-2} \simeq .003$$

$$C_{\cancel{44}\,23} = \frac{.00316}{6.21 \times 10^{+9}} = \boxed{.51\ pf}$$

TO CALCULATE $C_{\cancel{45}34}$

$$B^J_4 = w_0 C_{3,4} + w_0 C^{+}_{n} + \frac{w_0 C_{45}}{1 + \left(\frac{w_0 C_{45}}{G_B}\right)^2}$$

ESTIMATE $C_{34} = .75\,pf.$, $C_{45} = 1.0\,pf.$

$\cancel{B^J_4}$ $w_0 C_{45} = 6.21 \times 10^9 \cdot 1.0 \times 10^{-12} = 6.21 \times 10^{-3}$

$G_B = \frac{1}{50}$ $\quad \frac{w_0 C_{45}}{G_B} = \frac{6.21 \times 10^{-3}}{.02} = \frac{.621}{2} \simeq .310$

$$\left(\frac{w_0 C_{45}}{G_B}\right)^2 = .096, \quad \frac{w_0 C_{45}}{1 + (\quad)^2} = \frac{6.21 \times 10^{-3}}{1.096}$$

$$= 5.67 \times 10^{-3}$$

n=4

$$\frac{l_4}{\frac{\lambda_0}{4}} = .72$$

$$w_0 C_{3,4} = (6.21\times10^{9})(.75\times10^{-12}) = 4.66\times10^{-3}$$

$$w_0 C^{*}_{n} = 3.10\times10^{-3}$$

5.67
4.66
3.10
13.43

3w0 RESONATOR

$$B_4 = 13.43\times10^{-3}$$

$$\frac{B_4}{Y_0} = \frac{13.43\times10^{-3}}{.02} = \frac{1.343}{2} = .671$$

$$\therefore \frac{b_4}{Y_0} = 1.36, \quad b_4 = (1.36)(.02) = .0272$$

$$J_{34} = .2\sqrt{\frac{b_3 b_4}{g_3 g_4}} = \cancel{.2\sqrt{(1.770)(.818)}}$$

$$= .2\sqrt{\frac{(.023)(.027)}{(1.770)(.818)}} = (.2)\sqrt{4.29\times10^{-4}}$$

$$J_{34} = (.2)(2.07)\times10^{-2} = .414\times10^{-2}$$

$$\simeq .004$$

$$C_{34} = \frac{.004}{6.24\times10^{9}} \simeq \boxed{.65\,pf.}$$

$$J_{45} = \sqrt{\frac{G_B b_4 w}{g_4 g_5 \cdot 1}} = \sqrt{\frac{(.02)(.027)(.2)}{(.818)(1.355)}}$$

$$= \sqrt{.975\times10^{-4}} = .99\times10^{-2}$$

$$J_{45} \simeq .01$$

$\frac{J_{45}}{G_B} = \frac{.01}{.02} = .5$, $\left(\frac{J_{45}}{G_B}\right)^2 = .25$

$$\omega_0 C_{45} = \frac{J_{45}}{\sqrt{1-\left(\frac{J_{45}}{G_B}\right)^2}} = \frac{.01}{\sqrt{.75}} = \frac{.01}{.87}$$

$\omega_0 C_{45} = .0115$

$$C_{45} = \frac{.0115}{6.21\times10^{-9}} = \boxed{1.86\ pf.}$$

SINCE $f_0 = 1000$ mc.

$$\frac{\lambda_0}{4} = \frac{30\ \text{cm.}}{4 \quad 2.54} = 2.94''$$

TABULATING

$C_{01} = 2.82$

$C_{12} = .79$

$C_{23} = .51$

$C_{34} = .65$

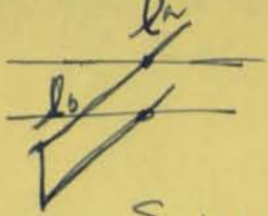
$C_{45} = 1.86$

$l_1/\lambda_0/4 = .560$, $l_1 = 1.65''$

$l_2/\lambda_0/4 = .630$, $l_2 = 1.85''$

$l_3/\lambda_0/4 = .530$, $l_3 = 1.56''$

$l_4/\lambda_0/4 = .720$, $l_4 = 2.12''$



FOR 3ω₀ STUBS: SHORTED STUB IS TWICE OPEN. $l_b = 2 l_a$

$l_{a_1} = \frac{1.65}{3} = .55$, $l_{b_1} = 1.10$

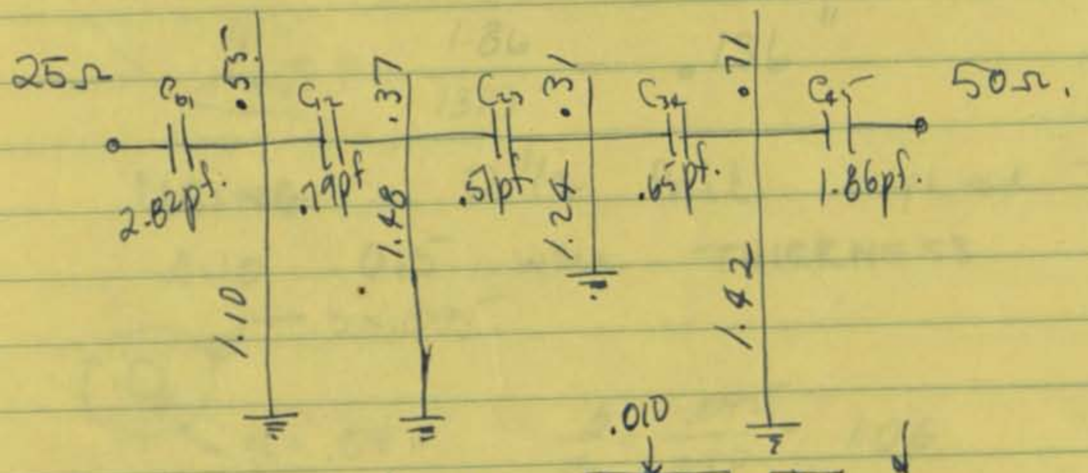
$l_{a_4} = \frac{2.12}{3} = .71$, $l_{b_4} = 1.42$

5ω₀ STUBS: SHORTED STUB IS ~~5~~ 4 TIMES OPEN $l_b = 4 l_a$

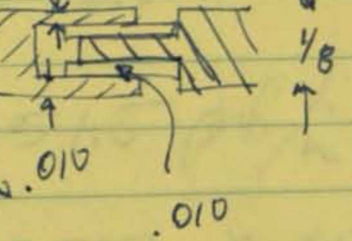
$l_{a_2} = \frac{1.85}{5} = .37$, $l_{b_2} = 1.48$

$l_{a_3} = \frac{1.56}{5} = .31$, $l_{b_3} =$ ~~1.28~~ 1.24

128
32
160

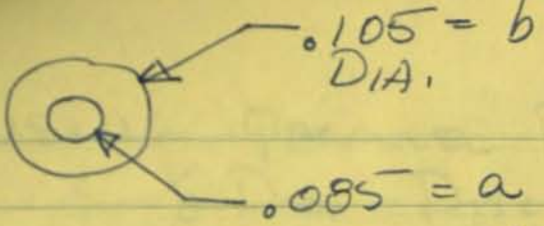


For C_{01} & C_{45} -



USING 10 mil TEFLON.

.125
-.020
.105
.020
.085



$$\frac{b}{a} = \frac{.105}{.085} = 1,24$$

$$C = \frac{.614k}{\log_{10}\frac{b}{a}} \ \mu\mu f/in$$

USING TEFLON

$$C = \frac{(.614)(2.1)}{\log 1.24} = \frac{1.29}{.094} = 13.7 pf/in$$

FOR $C_{01} = 2.82$ pf.

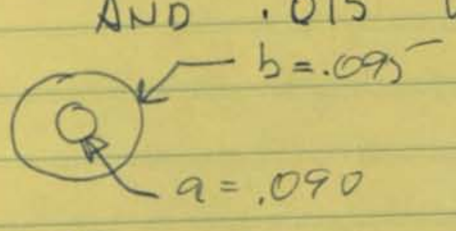
$$l_{01} = \frac{2.82}{13.7} = .206'' \ (\text{To LONG.!})$$

FOR $C_{45} = 1.86$

$$l_{45} = \frac{1.86}{13.7} = .136''$$

USING 2 1/2 Mil MYLAR TAPE
AND .015 WALL THICKNESS

$$\begin{array}{r} .125 \\ -.030 \\ \hline .095 \\ -.005 \\ \hline .090 \end{array}$$



$$\frac{b}{a} = \frac{.095}{.090} = 1.06$$

$$\log 1.06 = .025$$

$$C = \frac{1.29}{.025} = 51.5 pf/in$$

$$l_{01} = \frac{2.82}{51.5} = .0547 \cong \underline{.055}$$

$$l_{45} = \frac{1.86}{51.5} = \underline{.036}$$

pf.

USING PARALLEL PLATE CAP. – TEFLON
& 1/8 DIA. DISCS.

$$t = \frac{.0058}{C}$$

$$t_{12} = \frac{.0058}{.79} = .00735 \simeq \underline{\underline{.007}}$$

$$t_{23} = \frac{.0058}{.51} = \underline{\underline{.011}}$$

$$t_{34} = \frac{.0058}{.65} = \underline{\underline{.009}}$$

$f_1 = \overset{1.0\,\text{Kmc}}{1000\,\text{mc}}$ $f_2 = 1.2\,\text{Kmc}$

$n = 5$

$n f_1 = 5.0\,\text{Kmc}$, $n f_2 = 6.0\,\text{Kmc}$

FOR 5th HARM.

$\frac{2}{2n+1} = \frac{2}{11} \simeq 18\%$ $\frac{2\cancel{00}}{11\cancel{00}} = .182 \simeq 18\%$

FOR ADJACENT SIDE BANDS.

IF USE 5.4 TO 5.9 Kmc.

$\frac{5.4}{5} = 1.080\,\text{Kmc}$ $\frac{5.9}{5} = 1.18\,\text{Kmc}$

$\omega_0 = \frac{2\omega_a\omega_b}{\omega_a+\omega_b}$ $\cancel{2}\pi f_0 = \frac{\cancel{2}\,4\pi^{\cancel{2}} f_a f_b}{\cancel{2\pi}\,(f_a+f_b)}$

$\cancel{2\pi} f_0 = \overset{\cancel{2}}{\cancel{4\pi}}\,\frac{(1.08)(1.18)}{\underset{1.13}{\cancel{2.26}}} = \underline{1.13\,\text{Kmc}}$

For .2 db ripple

$g_1 = 1.3028$, $g_2 = 1.2844$, $g_3 = 1.9671$

$g_4 = .8468$, $\cancel{g}\ r_a \frac{1}{r} = .6499$

~ 1.54

$\delta = \omega_1'\left(\frac{\omega_b+\omega_a}{\omega_b-\omega_a}\right) = 1\ \frac{2.2}{.200} = 11.0$

$\frac{J_{45}}{Y_0} = \sqrt{\frac{\pi}{2\delta g_5 g_6}} = \sqrt{\frac{\pi}{2 \cdot 11 \cdot 1.5}} = \sqrt{.0953} = .031$

$\frac{B}{Y_0} = \frac{J/Y_0}{1-\left(J/Y_0\right)^2} = \frac{.0.31}{.047} = .66$

$\begin{array}{r} 1.000 \\ .095 \\ \hline .905 \end{array}$ $\ \ .900$ $\ \ .953$ $\ \ .047$

$Y_0 = \frac{1}{15\,\Omega}$

$B = \frac{.66}{15} = .044$, $C = \frac{.044}{2\pi\ 1.1 \times 10^9} = \underset{\sim}{6.4}\ \overset{u}{p}f.$

DATE 1-20 19 64

EQUIP. USED

FAIR

1.

2.

$$\frac{J_{01}}{Y_0} = \sqrt{\frac{\pi}{2\,\delta\, g_0 g_1}} = \sqrt{\frac{\pi}{2 \cdot 11 \cdot 1.3}} = \sqrt{.110}$$

$$= .332$$

$$\frac{B_{01}}{Y_0} = \frac{J/Y_0}{1-\left(J/Y_0\right)^2} = \frac{.332}{.890} = .373$$

$$\begin{array}{r} 1.000 \\ .110 \\ \hline .890 \end{array}$$

$$B_{01} = .0249 \;, \quad C_{01} = \frac{.0249}{2\pi\ 1.13 \times 10^9}$$

$$\sim \frac{25}{6}$$

$$\underbrace{C_{01} = 3.5\ pf.}$$

$$\frac{J_{45}}{Y_0} = \sqrt{\frac{\pi}{2\delta(1.54)(.847)}} = \sqrt{\frac{\pi}{2\delta\ 1.3}} = \frac{J_{01}}{Y_0}$$

$$\frac{K_{12}}{Z_0} = \frac{\pi}{2\delta\sqrt{g_1 g_2}} = \frac{\pi}{22\sqrt{(1.30)(1.28)}} = \frac{\pi}{(22)(1.29)}$$

$$= .111 \;, \left(\frac{K_{12}}{Z_0}\right)^2 = .0122$$

$$\frac{X_{12}}{Z_0} = \frac{K_{12}/Z_0}{1-\left(K_{12}/Z_0\right)^2} = \frac{.111}{.988} = \underbrace{.112}$$

$$\begin{array}{r} 1.000 \\ .012 \\ \hline .988 \end{array}$$

if $Z_0 = 15$, $X_{12} = 1.68 = \omega L_{12}$

$$L_{12} = \frac{1.68}{2\pi\ 1.13 \times 10^9} = \frac{1680 \times 10^{-12}}{2.26\pi} = \underbrace{237\ \mu\mu h.}$$

$$\underbrace{L_{12} = .237\ nh.}$$

$(8.9\times10^{-2})=$

81×10^{-4}

80.8

$$\frac{J_{23}}{Y_{*}}=\frac{\pi}{2\delta\sqrt{g_2g_3}}=\frac{\pi}{22\sqrt{(1.28)(1.97)}}=\frac{.143}{\sqrt{2.52}}$$

$$=\frac{.143}{1.59}=.089,\quad\left(\frac{J_{23}}{Y_0}\right)^2=.008,$$

$$\begin{array}{r}1.000\\ .008\\ \hline .992\end{array}$$

$$\frac{B}{Y_0}=\frac{J/Y_0}{1-\left(\frac{J}{Y_0}\right)^2}=\frac{.089}{.992}=\underset{\sim}{.091}$$

$$Y_0=\frac{1}{15}$$

$$B=\frac{.091}{15}=.00605$$

@ $f=1.13$ KMc.

$$C=\frac{.00605}{2\pi\ 1.13\times10^{9}}=\frac{6.05\times10^{-12}}{2.26\pi}=\underset{\sim\sim}{.85}\text{ pf.}$$

15Ω LINE IN K-9

$\sqrt{\varepsilon_r}\ 15=45\Omega.$

$\frac{W}{b}=1.6$, if $b=\frac{1}{4}$ $\qquad \frac{t}{b}=\frac{.002}{.125}$

$W=\frac{1.6}{4}=.4$

if $b=\frac{1}{8}$

$\underset{\sim\sim}{W=.2}$

For | TRANSFORMER $\quad Z_m=\sqrt{50\cdot15}=5\sqrt{30}$

$Z_m=27.4.$

$\sqrt{\varepsilon_r}\ Z_m=82.5$

$\frac{W}{b}=.67$

$$W=\frac{.67\text{or}}{8}=\underset{\sim\sim}{.084}$$

$Z = \omega L \quad \frac{1}{v_p C}$

$\frac{\cancel{c}}{sec} \quad \frac{h}{sec}$

$$Z_1 = \sqrt{\frac{L}{C}}$$

$$\beta = \omega \sqrt{LC}$$

$$\frac{\omega}{\beta} = \frac{1}{\sqrt{LC}} = v_p$$

$$v_p^2 = \frac{1}{LC}, \quad C = \frac{1}{v_p^2 L}$$

$$Z_0 = \sqrt{\frac{L}{\frac{1}{v_p^2 L}}}$$

1.6

$$Z_0 = v_p L$$

$Z_0 = \frac{c}{\sqrt{\varepsilon_r}} L$ henries/cm.

Desire $.237 \times 10^{-9}$ Henries in $.125''$ length

$.125 \times 2.54 = .318$ cm.

$$\frac{.237 \times 10^{-9}}{.318} = .745 \times 10^{-9} \text{ hen/cm.}$$

$\sqrt{\varepsilon_r} = 3$ for K-9

for crot

$$Z_0 = \frac{\cancel{3} \times 10^{10}}{\cancel{3}} .745 \times 10^{-9} = 7.45 \Omega$$

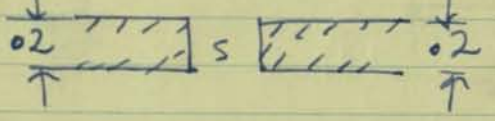
$\sqrt{\varepsilon_r} Z_0 = 22.4 \Omega \qquad \frac{D}{b} = .182, \; D = \frac{.82}{8} = .1$

let length be .0625

Then $\sqrt{\varepsilon_r} Z_0 = 44.8 \Omega$.

$\frac{D}{b} = .6 \qquad D = .66 = .60 \frac{1}{8} = .075''$

TO CALCULATE $C = .85$ pf
WITH .2 WIDTH



$\epsilon = .0885\, \epsilon_r$ pf/cm

$\epsilon_r = 9$

$\epsilon = .7965$

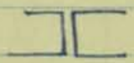
$$C_{f_0} = \frac{.85}{(.2)(2.54)} = 1.67 \text{ pf/cm}$$

$\frac{4}{2}$

$$\frac{C_{f_0}}{\epsilon} = \frac{1.67}{.80} = 2.1$$

$$\frac{s}{b} = \overset{.025}{\cancel{.03}}, \quad b = \frac{1}{8}$$

$$S = \frac{.025}{8} \cong \overset{.003}{\cancel{.004}}$$



TRY $.005 = S$

Cal. of C=3.5 pf.

CONSIDER OVERLAP OF .084 WIDE TRANSFORMER WITH .005 TEFLON.

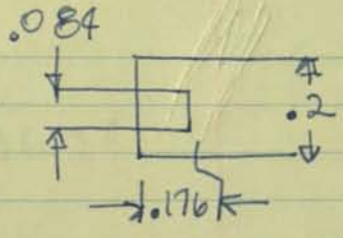
$$C = \frac{.225\, A\, k}{t}$$

$$A = \frac{C\, t}{.225\, k} = \frac{3.5 \times 10^{-12}\,(5 \times 10^{-3})}{.0225 \quad 2.1}$$

$$A = \frac{(3.5)(5)}{(.225)(2.1)} \times 10^{-3} = 37 \times 10^{-3}$$

$$l \times .084 = .037$$

$$l = \frac{.037}{.084} = .44$$



TRY .002 THICKNESS

$$A = 37 \times 10^{-3} \; \frac{2}{5}$$

$$A = 14.8 \times 10^{-3}$$

$$l = \frac{.015}{.084} = \underset{\sim}{.176}$$

~~FOR INDUCTANCES – SHUNT.~~

~~FOR SHORTED 15 Ω LINE.~~

~~$jX = j Z_0 \tan \Theta$~~

~~$\tan \Theta = \frac{X}{Z_0} = \frac{.237 \times 10^{-9}}{15} \; \underline{u} \;\; \Theta = \frac{2\pi}{\lambda} l$~~

~~$\lambda = \frac{V_p}{f} = \frac{c}{\sqrt{\epsilon_r} f} = \frac{\cancel{3} \times 10^{10}}{\cancel{3} \; 1.1 \times 10^{9}} = \frac{10}{1.1} \text{ cm.} = 9.1$~~

~~$\lambda = 3.58''$~~

~~$l = \frac{.237 \times 10^{-9}}{15} \; \frac{3.58}{2\pi}$~~

$$\frac{J_{01}}{Y_0} = \tan^{-1}\frac{\phi}{2} = .332$$

$$\frac{\phi}{2} = 18.35^\circ \ , \ \phi = 36.7^\circ$$

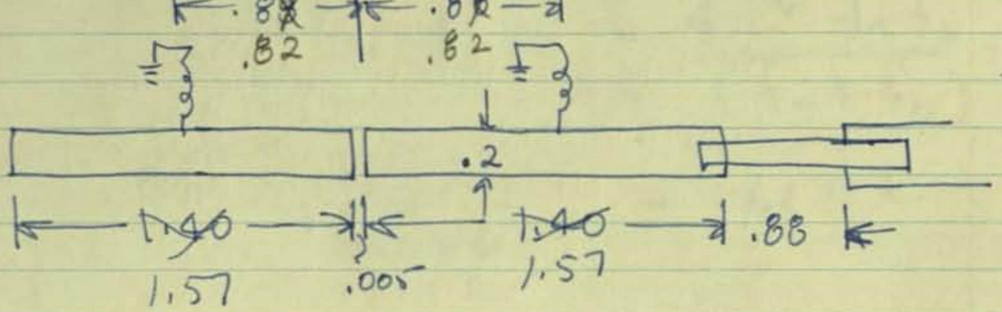
$$\frac{360^\circ}{36.7^\circ} = \frac{3.58}{x}$$

$$\frac{3.58}{2} = 1.76$$

$$x = .365'' \ , \ \frac{x}{2} = .182$$

$$\frac{1.76}{2} = .88$$

LENGTH OF RESONATORS = $1.76 - .\cancel{36}\overset{.19}{} = \cancel{1.40}$



$$\begin{array}{r} 1.76 \\ .19 \\ \hline 1.57 \end{array}$$

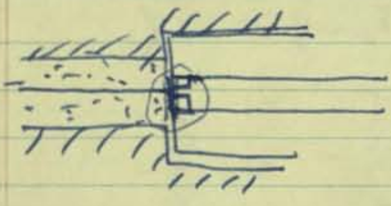
FOR A 50Ω LINE

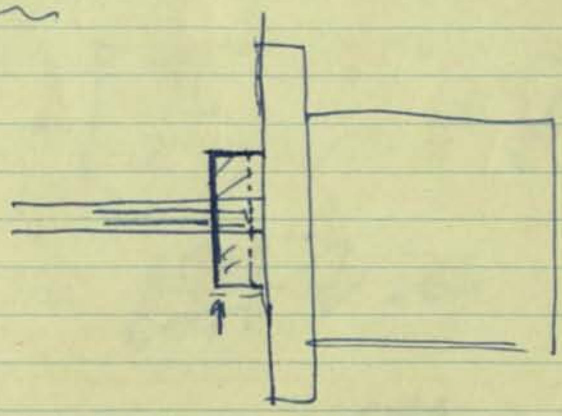
$\sqrt{\epsilon_r}\ 50 = 150$

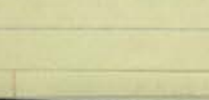
$\frac{w}{b} = .19 \ , \ b = \frac{1}{8}$

$w = \frac{.19}{8} = .02\cancel{4}$

$$\begin{array}{r} 1.57 \\ 1.57 \\ .88 \\ .88 \\ \hline 4.90 \end{array}$$







L = .0237 nh.

Consider K_{12} for ~~[illegible]~~ negative line lengths.

$\frac{K_{12}}{Z_0} = .111$, $\left(\frac{K_{12}}{Z_0}\right)^2 = .0122$

$\frac{X_{12}}{Z_0} = \frac{K/Z_0}{1-\left(\frac{K}{Z_0}\right)^2} = \frac{.111}{.988}$

$$\begin{array}{r} 1.000 \\ .012 \\ \hline .988 \end{array}$$

$\frac{X_{12}}{Z_0} = .112$

$\tan\frac{\phi}{2} = \frac{K}{Z_0} = .111$

$\frac{\phi}{2} = 6.4^0$ $\phi = 12.8^0$

$\frac{360}{12.8} = \frac{3.58}{x}$, $x = .127''$

$\frac{x}{2} = .063$

L = .237 nh

using 15Ω $\frac{X_{12}}{Z_0} = .112 = \tan\theta$

$\theta = 6.4^0$

$l = .063''$

if $l = .125$ $\theta = 12.6^0$

$\tan\theta = .223$

$\frac{X}{Z_0} = .223$

$Z_0 = \frac{X}{.223} = \frac{1.64}{.223}$

$= 7.35\Omega.$

$(7.35)\sqrt{\varepsilon} = 22\Omega.$

$\frac{W}{b} = 3.75$

$W = \frac{3.75}{8} = .47$

$\frac{360}{\theta} = \frac{3.58}{.125}$

$\theta = 12.6$

$\theta = \frac{360}{8.56}$

$X = \omega L$

$X = 2\pi \times 1.1 \times 10^9$

$.237 \times 10^{-9}$

$X = (2.2\pi)(.237)$

$= 1.64$

DATE 2-18 1964
EQUIP. USED Boonton 75A-SB
TAKEN BY RH
REQUESTED BY D Jones

FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

ENGINEERING DATA

( ) T. CLASS
REMARKS
CUSTOMER
GROUP 704-7 Specia

LOT No.	DE.	OP.	GR.	TYPE No.	CL.	TE.	COND.	DATE	ELAPSED TIME	SP.	SP.

LOT No.	UNIT No.	OSC LEVEL .2V C (pF)	R	G @ 1V (mA)						
	51	.26	1M	—						
	52	.57	5	OPEN						
	53	.69	100	OPEN INTER.		0 output				
	54	.74	5	23						
	55	.72	8	46		7 mW				
	56	.85	12	30						
	57	.87	1.1	10						
	58	.60	2	53						
	59	.81	8	27						
	60	.70	3	18						
	61	.75	3	35						
	62	.72	4	5						
	63	.74	1	80						
	64	.78	2	44						
	65	.71	4	46						
	66	.66	2	30	4 mW					
	67	.82	3.7	<5						
	68									
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