17-4-55

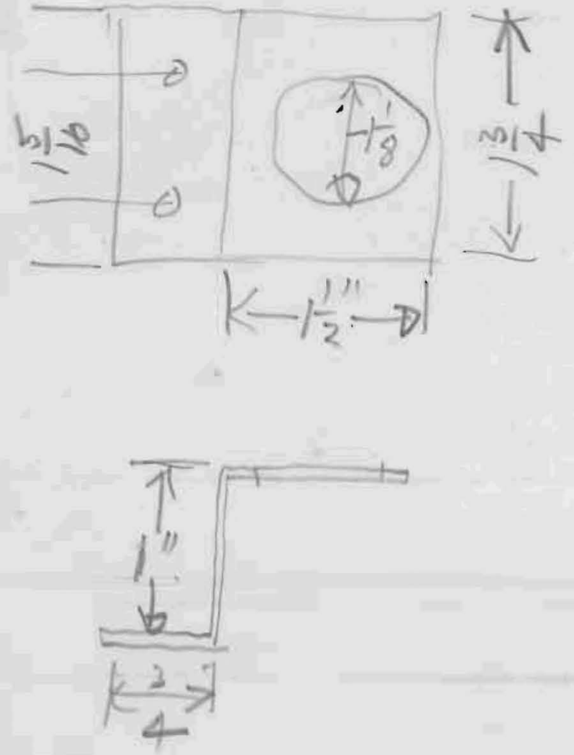
Beat Oscillator Coil

Winding #31 B+S .0089" dia
Winding 2 3/8" long, 7 1/5 turns
Coil form 3" long, 1 1/8" dia.
Holes for #8 BA screws 1/8" from edge
Inductance 732 μh at 790kc

Freq	C	Q
280kc	463pf	89
560kc	1125pf	120
1100kc	27pf	116

Primary 13/32" long.

Bracket for socket



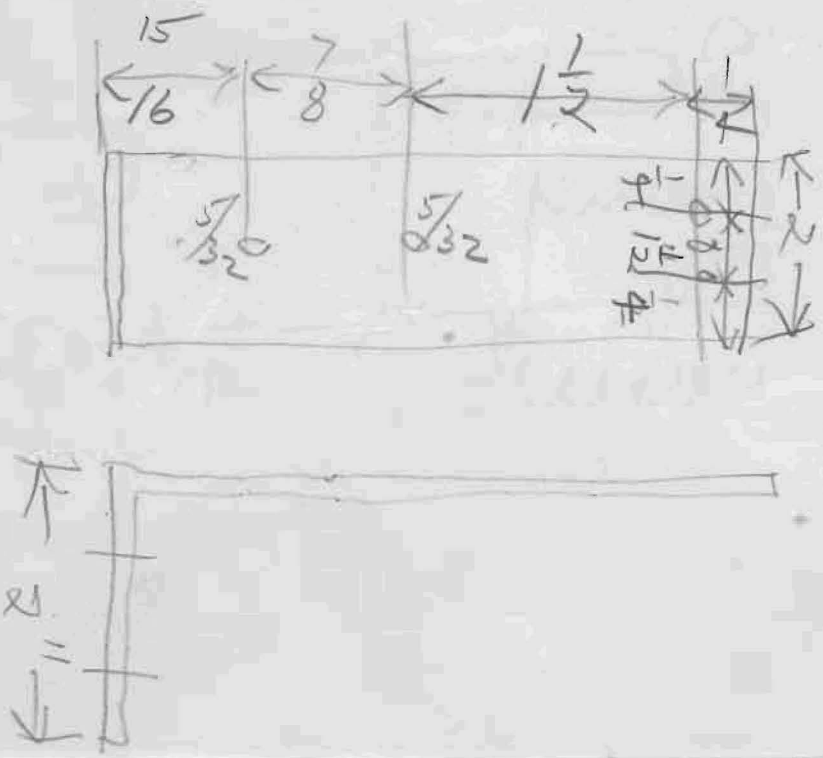
pc $3\frac{1}{4} \times 1\frac{3}{4}$

THE UNIVERSITY OF TASMANIA

VOUCHER NUMBER.

Dr. to ....

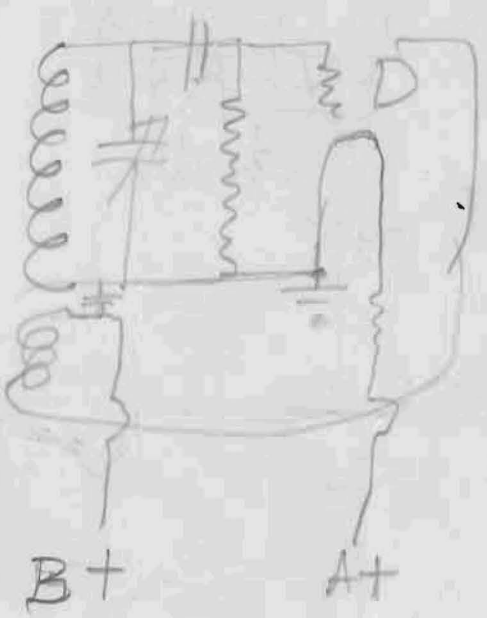
....

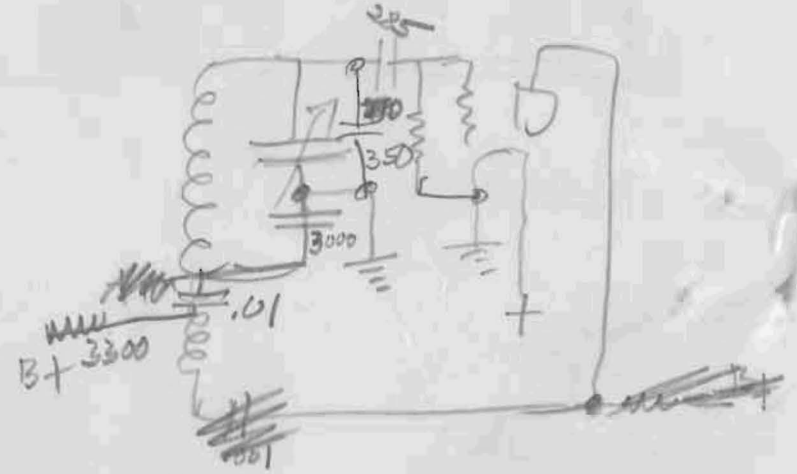
DATE, 19		AMOUNT. £	s.	d.
	 Bracket for condenser			

420
165
585 variation

655
75
580 variation

500 pf
shunt





16/3/62
Obsolete data

2nd I.F. Stage, 2 volts output, 53.1 ma tube

15K Ω cathode resistor; 100K Ω load resistor.

Gain vs Frequency

$E_C = +12V$

Freq KC	Input mv	Gain DB
150	300	16.5
180	170	21.4
200	73	28.7
210	49	32.2
220	45	33.0
230	52	31.7
240	61	30.3
244	63	30.0
250	58	30.7
260	52	31.7
270	49	32.2
280	45	33.0
290	46	32.8
300	59	30.6
320	116	24.7
350	245	18.2

Response with Mistuning

Primary turns	Peak KC	Peak mv	Dip KC	Dip mv	Peak KC	Peak mv
Correct	220	45	244	63	280	45
+6	218	43	242	61	277	46
+14	216	40	241	59	275	47
+34	210	36			267	52
+74	200	30			265	62

Output Volts versus B & C Volts

	E_B 157v		166v		175v	
Input mv	Output %	I_K ma	Output %	I_K ma	Output %	I_K ma
$E_C = +4.5V$						
84	-1.0	.52	100	.54	+1.0	.56
$E_C = +7.5V$						
72	-0.5	.68	100	.70	+0.5	.73
$E_C = +12V$						
63	-0.3	1.05	100	1.07	+0.3	1.09
$E_C = +16.5V$						
57	-0.2	1.25	100	1.27	+0.2	1.30

(over)

2nd I.F. Transformer,

Primary = 3" I.D., 3/4" long, 4 Pi

D.C. resistance: Primary 61 ohms, Secondary 131 ohms

1 KC inductance: Pri. 16.7 mh, Sec. 95.0 mh,

$L_p + L_s + 2M = 136$ mh, $L_p + L_s - 2M = 84$ mh, $M = 13$ mh, $K = 33\%$

Radio Frequency Measurements on Q machine, Assembled Transformer with diodes connected,

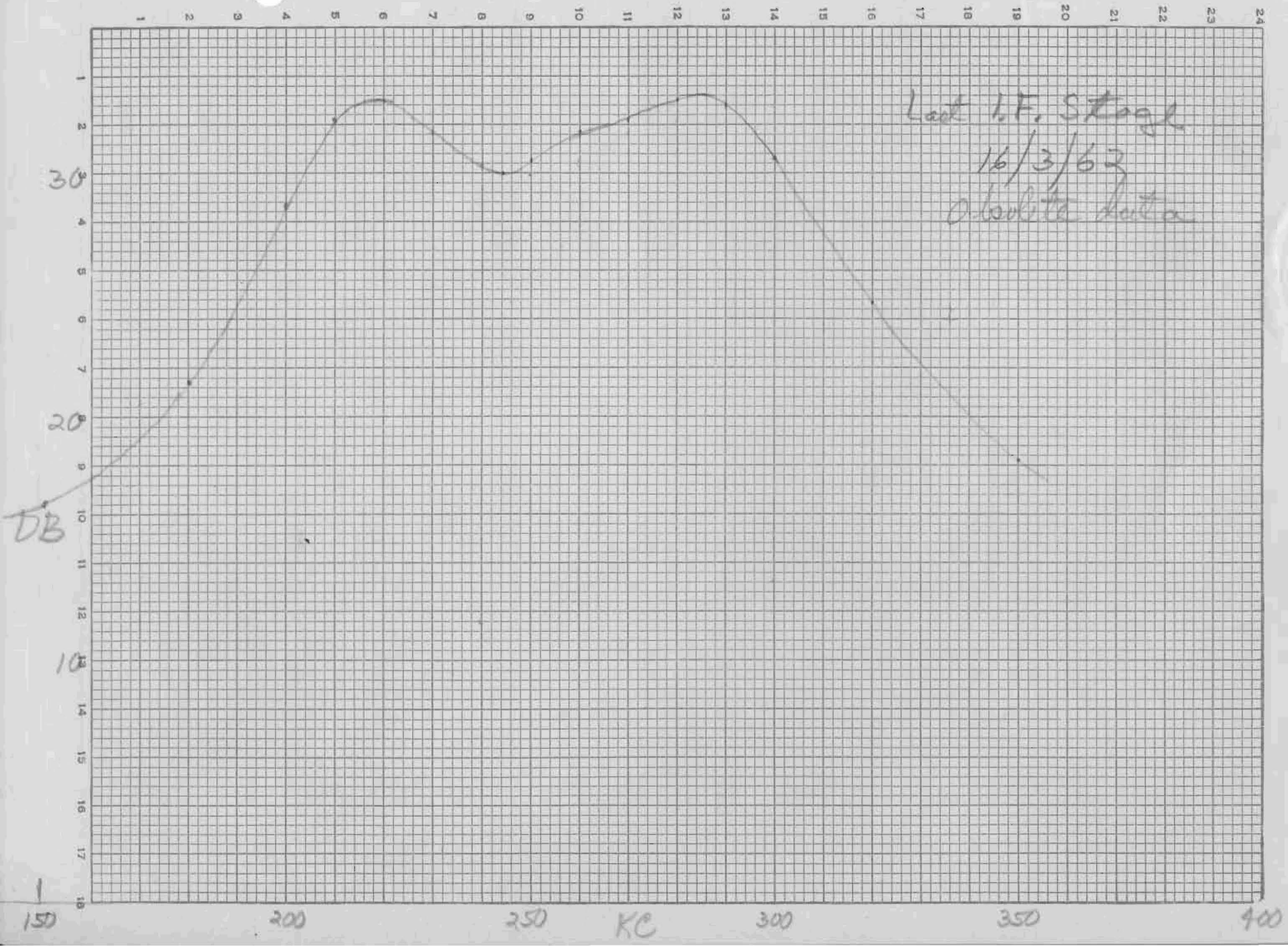
	Freq KC	Cap pf	Q	R ohms		Notes
Primary	60	390	85	76	$C_o = 23.3$ pf	
	120	80	85	151	$L_o = 17.0$ mh	
	173	27?	40	462	$R = 107$ KC/Q	
Secondary	50	98	167	180	$C_o = 8.0$ pf	
	70.7	45	155	275	$L_o = 96$ mh	
	89	27?	130	412	$R = 602$ KC/Q	
L_p+L_s+2M	50	63	235	186	$C_o = 10.0$ pf	Q probably
	70.7	26.5	215	287	$L_o = 139$ mh	is too high
					$R = 873$ KC/Q	causing
L_p+L_s-2M	50	108	160	166	$C_o = 12.0$ pf	R to be
	70.7	48	165	218	$L_o = 85$ mh	too low
	89	27?	155	305	$R = 531$ KC/Q	L_o is correct.

when $\omega_2 = 2\omega_1$; $C_o = (C_1 - 4C_2)/3$ $M = 13.5$ mh, $K = 33\%$

when $\omega_2 = \sqrt{2}\,\omega_1$; $C_o = (C_1 - 2C_2)/1$

Capacity for 250 KC
Primary 24.3 pf
Secondary 4.27 pf

when $\omega_2 = 3\omega_1$; $C_o = (C_1 - 9C_2)/8$

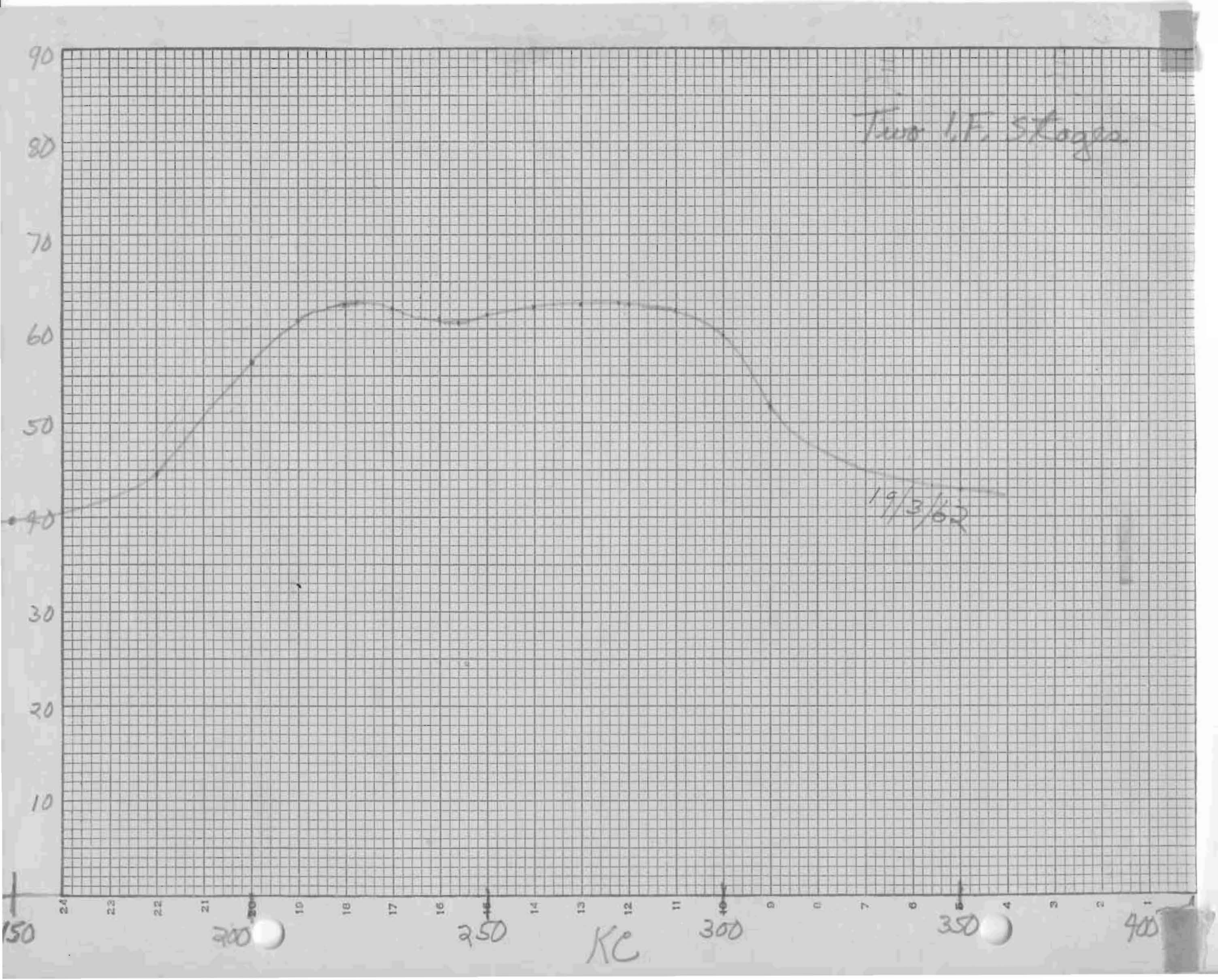

Last I.F. Stage
16/3/62
obsolete data
30
20
10
DB
150
200
250
300
350
400
KC

19/3/62

Comparison of Voltage Indications on General Radio Signal Generator with Hewlett Packard Vacuum Tube Voltmeter.

Signal Generator	VTVM 1 volt scale	Signal Generator	VTVM 3 volt scale
0.2	0.21	0.8	0.85
0.36	0.36	1.4	1.41
0.80	0.80	2.0	2.08
		3.0	3.10

The VTVM is a peak reading instrument calibrated in rms for a sinewave. Actual peak voltage at input is always $\sqrt{2} = 1.414$ times the meter indication irrespective of wave shape.


Two I.F. Stages
19/3/62
90
80
70
60
50
40
30
20
10
150
200
250
300
350
400
KC

First I.F. Stage
19/3/62
DB
30
20
10
1
Kc
150
200
250
300
350
400

19/3/62
Obsolete

First I.F. Stage, 0.5V output, 51.8ma tube
15KΩ cathode resistor, 56KΩ load, H.P. VTVM.

Gain vs Frequency
$E_c = +12V$

Freq. KC	Input mv	Gain DB
150	50	20.0
180	26	25.7
200	17.1	29.4
210	15.0	30.5
220	13.5	31.4
230	13.0	31.7
240	12.6	32.0
250	12.6	32.0
260	12.8	31.9
270	13.0	31.7
280	13.6	31.3
290	14.5	30.8
300	15.7	30.1
320	20.0	28.0
350	28	25.1
400	46	20.8

Regulation at $E_c = +12V$

E_B volts	157	166	175
I_K ma	0.99	1.01	1.03
Output %	<-0.1	100	<+0.1

imperceptable change

Gain versus Load Resistance

Freq. KC	Input mv	Gain DB	
100KΩ load			
204	9.4	34.5	Peak
242	11.4	32.9	Dip
294	9.6	34.4	Peak
220KΩ load			
183	6.4	37.9	Peak
220	10.5	33.6	Dip
280	5.2	39.7	Peak
Load removed			
180	3.3	43.6	Peak
223	10.6	33.5	Dip
284	2.1	47.6	Peak

Overload and Clipping

Input mv	Output volts	Input mv	Output volts
1	0.04	100	1.31
2	0.08	200	1.39
5	0.20	360	1.41
10	0.40	800	1.42
20	0.77	1400	1.47
50	1.24	2000	1.51
	(over)	3600	1.53

The fixed cores in primary & secondary are in contact without airgap to give tightest coupling.

First I.F. Transformer

Capacity coupling aids inductive coupling.

D.C. resistance: Primary 49 ohms, Secondary 49 ohms

1 KC inductance: Pri. 25.9 mh, Sec 24.4 mh

$L_p + L_s + 2M = 60.7$ mh, $L_p + L_s - 2M = 39.5$ mh, $M = 5.3$ mh, $K = 21\%$

Radio Frequency Measurements on Q machine

	Freq KC	Cap pf	Q	R ohms		
Primary	50	381	140	59	$C_0 = 5.7$ pf	
	100	91	164	100	$L_0 = 26.2$ mh	
	176	?	124	234	R = 165 KC/Q	
Secondary	50	404	134	58	$C_0 = 6.7$ pf	
	100	96	160	97	$L_0 = 24.7$ mh	
	180	?	119	235	R = 155 KC/Q	
L_p+L_s+2M	50	157	137	143	$C_0 = 5.7$ pf	Q probably is too low causing R to be too high. L_0 is correct
	100	35.1	96	406	$L_0 = 62.2$ mh	
	114	?	106	419	R = 390 KC/Q	
L_p+L_s-2M	50	246	109	117	$C_0 = 4.5$ pf	
	100	57	103	247	$L_0 = 40.4$ mh	
	142	?	75	481	R = 254 KC/Q	

$M = 5.45$ mh, $K = 21\%$

Capacity for 250 KC

Primary 15.5 pf

Secondary 16.5 pf.

21/3/62

Filter Output Coupler (Obsolete)

Coupler is I.F. transformer of 19/3/62,
Input 0.32 volts from Sig Gen.; 52,000 ohm dummy,
11pf primary condenser; H.P. VTVM output meter

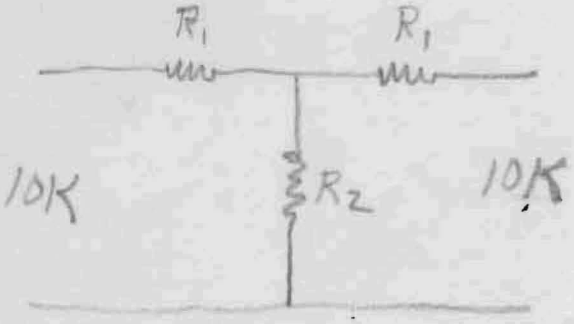
Load	56,000 ohms		220,000 ohms		Load Removed	
Freq KC	Output Volts	Gain DB	Output Volts	Gain DB	Output Volts	Gain DB
150	.05	-10.1	.06	-8.5	.08	-6.0
180	.09	-5.0	.17	0.5	.20	1.9
200	.12	-2.5	.26	4.2	.42	8.4
220	.14	-1.2	.25	3.9	.35	6.8
240	.15	-0.6	.24	3.5	.29	5.2
260	.16	0.0	.24	3.5	.28	4.9
280	.16	0.0	.25	3.9	.30	5.5
300	.16	0.0	.26	4.2	.33	6.3
320	.16	0.0	.27	4.5	.35	6.8
350	.14	-1.2	.24	3.5	.29	5.2
400	.12	-2.5	.17	0.5	.19	1.5
500	.08	-6.0	.10	-4.1	.11	-3.3

Theoretical

Gain DB	0.3	6.3	?

Primary inductance much too large.

Filter termination. 22/3/62



$R_1 = 10K\left(\frac{\alpha-1}{\alpha+1}\right)$

$R_2 = 10K\left(\frac{2\alpha}{\alpha^2-1}\right)$

Filter band, KC	6	12	25	none
(a) Insertion loss DB	4.0	2.7	1.9	0
(b) Bandwidth in DB	0	3.0	6.2	9.2
Required loss in DB $4.0-a+b$	0	4.3	8.3	13.2
Ratio α	1.00	1.64	2.60	4.57
$\alpha-1$	0	.64	1.60	3.57
$\alpha+1$	1.00	2.64	3.60	5.57
α^2	1.00	2.69	6.76	20.9
α^2-1	0	1.69	5.76	19.9
R_1 ohms	0	2430	4450	6400
R_2 ohms.	∞	19400	9020	4600

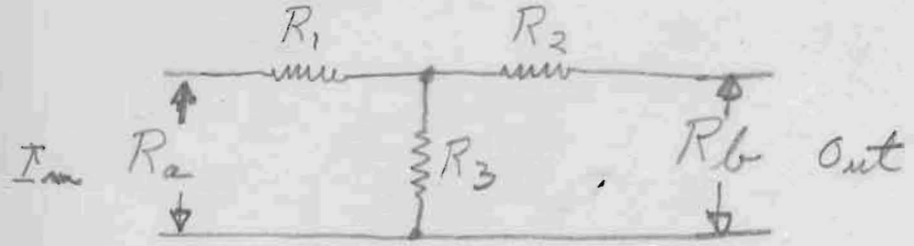
$\alpha = \frac{\text{load current without attenuator}}{\text{load current with attenuator}}$

True only for symetrical networks where input = output = image impedance

Penler & McIlwain
1950, p 11-99

28/3/62

T attenuators



$$\alpha = 2.306 \log_{10}(I_b/I_a)$$

$$R_1 = \frac{(R_a + R_b)\tanh\left(\frac{\alpha}{2}\right) + R_a - R_b}{2}$$

$$R_2 = \frac{(R_a + R_b)\tanh\left(\frac{\alpha}{2}\right) - R_a + R_b}{2}$$

$$R_3 = \frac{(R_a + R_b)}{2\sinh\alpha}$$

$$\tanh(x) = \frac{e^x - e^{-x}}{e^x + e^{-x}}, \quad \sinh(x) = \frac{e^x - e^{-x}}{2}$$

$e = 2.718$ & when $x = \frac{\alpha}{2}$

$$\tanh\left(\frac{\alpha}{2}\right) = \frac{e^\alpha - 1}{e^\alpha + 1}, \quad \sinh\left(\frac{\alpha}{2}\right) = (e^\alpha - 1)/2e^{\alpha/2}$$

27/4/62

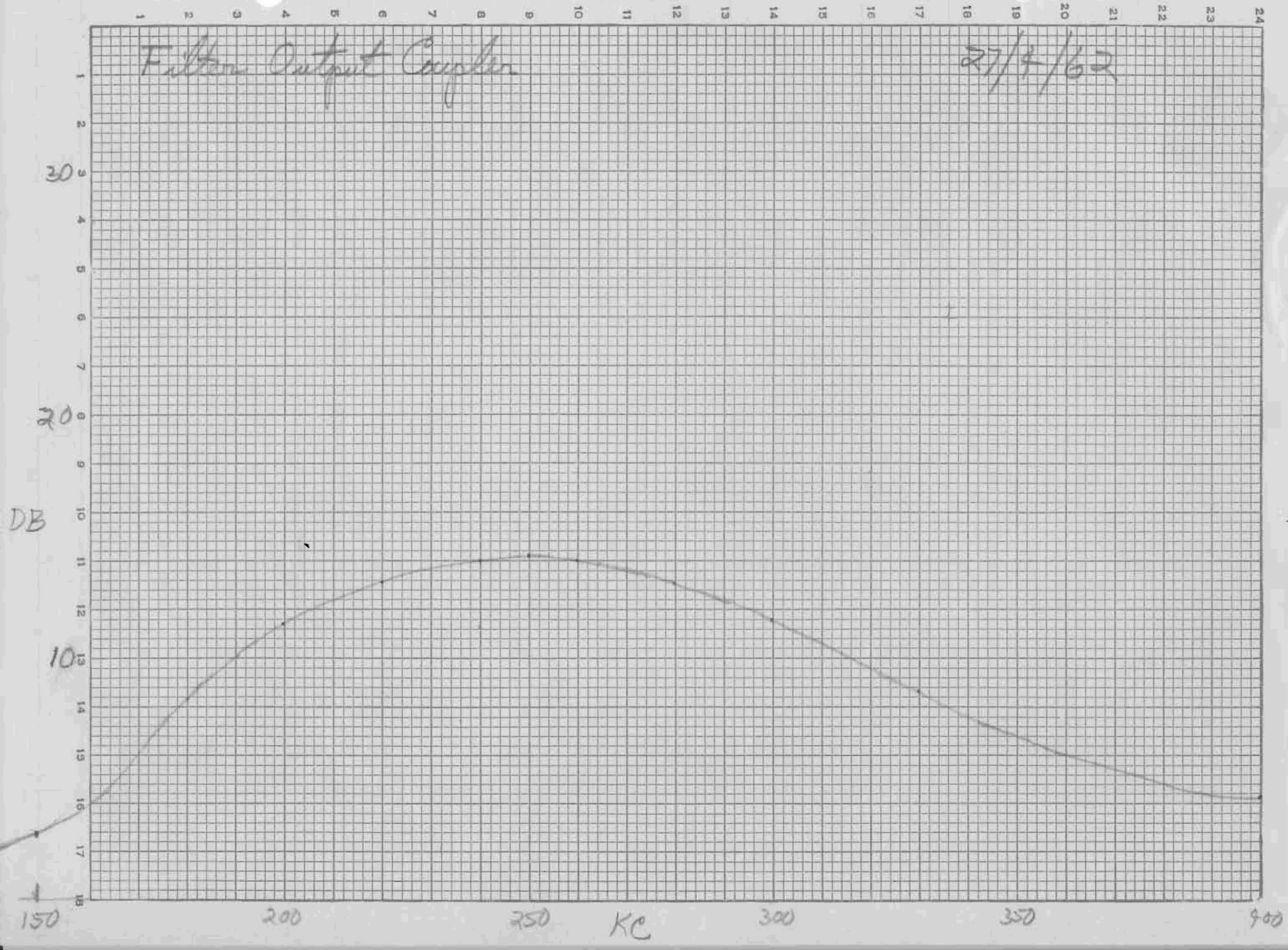
Filter Output Coupler

Input 0.2 volts from Sig Gen.; 10,000 ohm dummy
220,000 ohm load; H.P. VTVM output meter

Freq. KC	Output Volts	Gain DB
150	.14	2.9
180	.26	8.3
200	.37	11.4
220	.45	13.1
240	.50	14.0
250	.51	14.2
260	.50	14.0
280	.45	13.1
300	.38	11.6
330	.27	8.6
400	.16	4.1
500	.10	0.0

Theoretical Gain $(220,000/10,000)^{1/2}$ = 4.7 times = 13.4 DB
Circuit slightly undercoupled. Could use a bit larger primary inductance and smaller capacity. This will require a marked reduction in primary C_o.

(over)



Filter Output Coupler
27/7/62
30
20
DB
10
150
200
250
KC
300
350
400

30/4/62

1st I.F. with 100K Ω load. Output 1/2 volt.

Freq KC	Input mv.	Gain DB
150	40	
180	16.2	
200	9.5	
205	9.2	
210	9.8	
220	10.7	
230	10.4	
240	11.8	
250	11.8	
260	11.5	
270	10.7	
280	10.1	
290	9.5	
295	9.2	
300	9.6	
330	15.8	
400	39	
500	71	

Input mv.	Gain DB	Input mv	Gain DB.
8.6		7.6	
5.5		5.8	
.10		.92	
.50		.52	
.50		.52	
.64		.66	
.78		.82	
.78		.80	
.68		.72	
.61		.62	
.52		.54	
.50		.52	
		.67	
.66			
2.2		2.4	
30		32	

Input to low side Filter output coupler. 10000 Ω dummy.

Output 2 volts D.C.

~~[illegible]~~

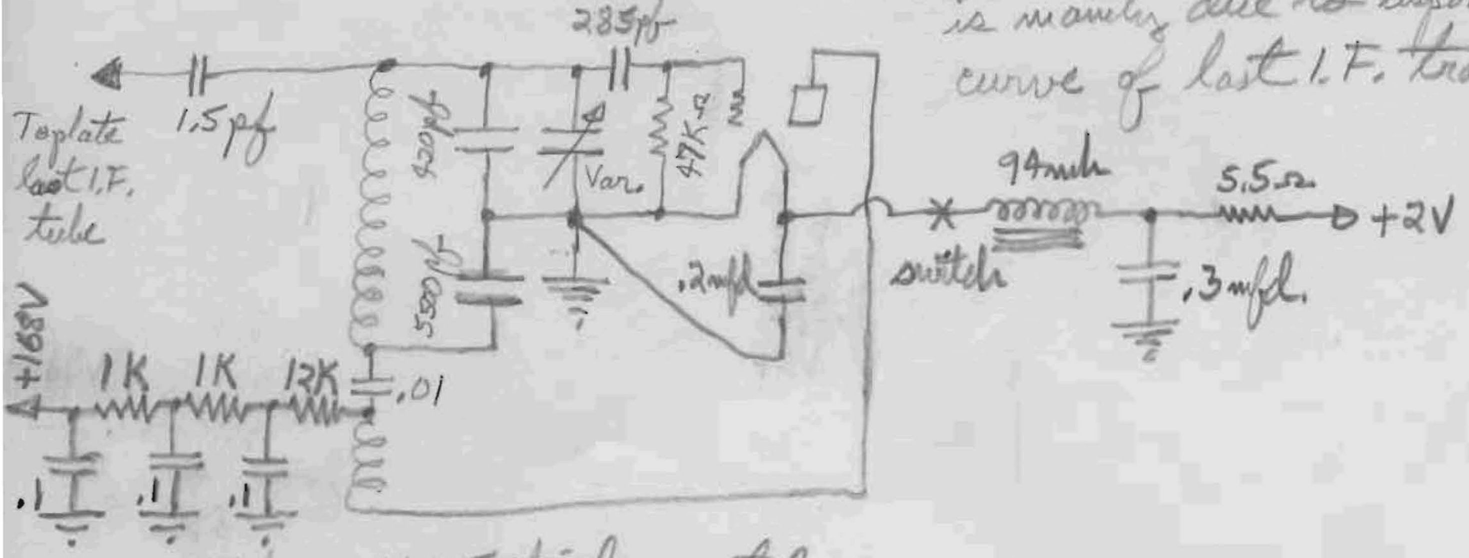
3/5/52

Beat Oscillator.

Freq KC	Dial. Div.	Output Volts	Plate Ma
208	0	1.09	4.08
220	16	1.29	4.05
230	27	1.11	4.02
240	36.5	.97	4.00
250	46	1.00	4.00
260	55	1.11	3.98
270	64.5	1.21	3.97
280	77.5	1.28	3.96
290	94	1.19	3.95
291	100	1.18	3.95

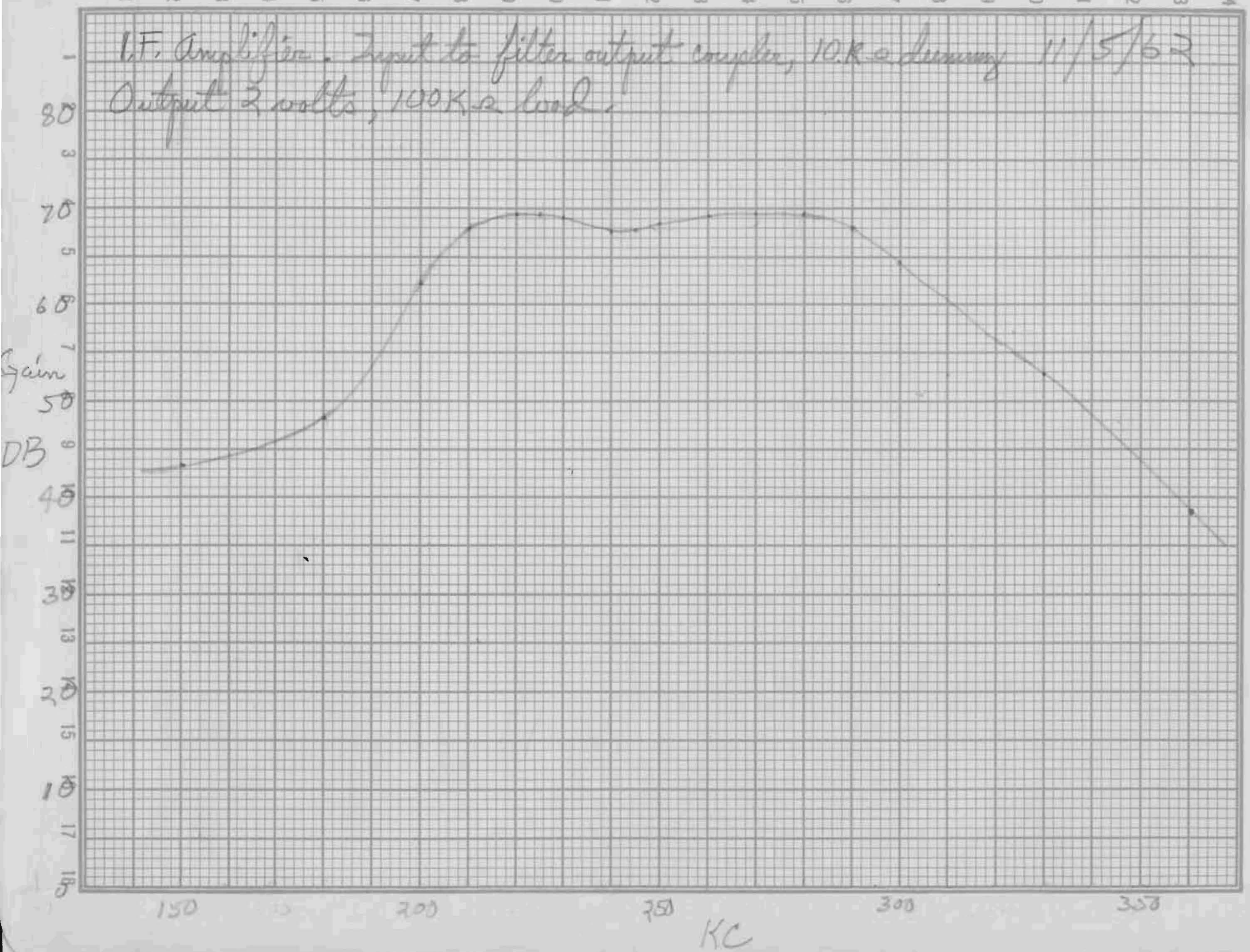
$E_B = 166v$, $E_p = 95v$, 51.8 ma tube.

These readings are taken with last I.F. tube in place and plate voltage turned on. If plate voltage is removed the output volts are slightly (5%) higher due to removal of plate load resistance of last I.F. tube from tuned circuit. The variation of output volts with frequency is mainly due to response curve of last I.F. trans.



Tube is 1LN5 triode connected.

Variable condenser 420 + 165 = 585pf variation.


I.F. Amplifier. Input to filter output coupler, 10K Ω dummy 11/5/62
Output 2 volts, 100K Ω load.
Gain DB
80
70
60
50
40
30
20
10
0
150
200
250
300
350
KC

11/5/62

Input to Filter output Coupler.
10,000 ohm dummy; 56,000 Ω across 1st I.F. trans. secondary.
Output 2 volts D.C., 100,000 Ω load.

KC Freq.	mv input	DB Gain.
150	13.2	43.6
180	7.8	48.2
200	1.52	62.3
210	0.80	68.0
220	0.68	69.4
225	0.68	69.4
230	0.70	69.1
240	0.81	67.8
246	0.81	67.8
250	0.76	68.4
260	0.71	69.1
270	0.68	69.4
280	0.69	69.4
290	0.80	68.0
300	1.22	64.3
330	4.60	52.8
360	13.6	43.4
~~500~~		

2/8/62

Mixer Output Performance

Frequency KC	Input mv	Gain DB
150	300	-3.5
180	126	4.0
200	69	10.8
220	45	12.9
230	42	13.6
240	39	14.2
250	38	14.4
260	39	14.2
270	41	13.8
280	43	13.3
300	50	12.0
350	98	6.2
400	172	1.3
500	320	-4.1

$E_p = 160v$ $I_p = 0.6 ma$

$E_{SG} = 110v$ $I_{SG} = 1.0 ma$

$E_K = 16v$ $I_K = 1.6 ma$

$E_G = -3.6v$

$E_B = 162v$ $E_c = +12v$

Plate isolation 3.5K Ω

Screen resistor 50K Ω

Cathode resistor 10K Ω

Output 0.2v across 10K Ω load

Input at Mixer grid.

Grid cap removed & 3300 Ω inserted to prevent mixer grid coil from shorting signal generator.

11/12/62

Test of Germanium Diodes

Back voltages varied from 0.8 to 1.8 volts. $\Delta E = 1.0$ volts. Type OA95

Back current has considerable scatter. In general $\Delta I = 0.15$ microampere when $I = 1\mu a$ at $E = 1.3V$ with ΔI being proportional to I. Thus Dynamic back resistance is about

$$\Delta R = 7.5 \cdot 10^6 / I = 7.5 / I \text{ megohms where}$$

I is in microamperes.

The two diodes placed in receiver have I about $0.9\mu a$. Three more diodes with I between 1.1 and 1.3 μa are fastened to inside compartment with adhesive tape. These are all very temperature sensitive and must be held tightly in pliers when soldering to prevent heat flowing into diode.

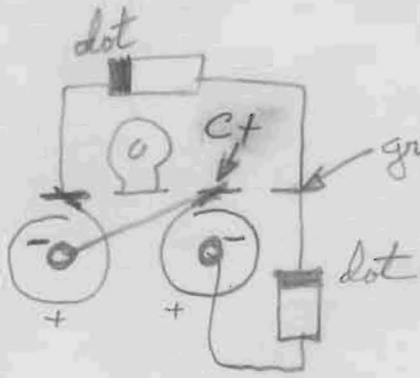
(over)

14/12/62

One of the OA95 diodes was found to have back current of over 6μa. Both were removed and replaced by BGE diodes in glass envelopes. These are quite similar and have back currents of about 4μa each.

also it was found that Mallory cells made poor contact in holder and caused diode to operate at zero voltage. Under this condition the diodes have very low back resistance and act as a short circuit on I.F. transformer.

17/12/61



Diodes installed are Raytheon IN67.
At 1.35V from Mallory cell
Back current 3 μa
Back resistance 450,000 Ω
Forward current 13 ma
Forward resistance 100 ohms

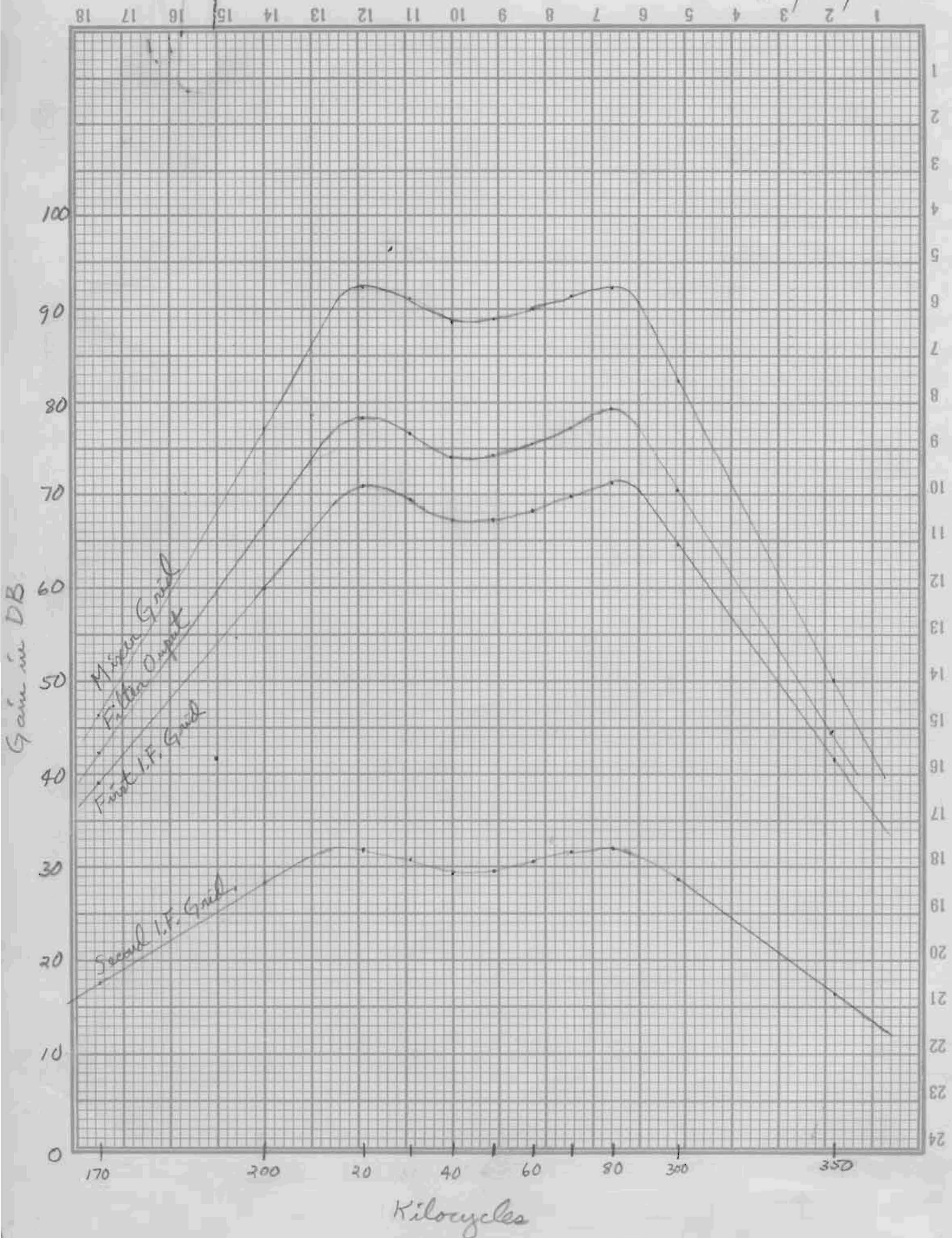
See 19/3/62 for performance of this limiter on output of first I.F. stage. A maximum of 1.53V rms appears across limiter. The waveform will be nearly square. ~~Thus when VTVM indicates 1.53V the peak is actually $\sqrt{2} \times 1.53 = 2.16$ volts. This is top of square wave. Consequently the grid on last I.F. stage should have a negative bias slightly greater than 2.16V, or say 2.5 volts. If this is maintained the grid will never go positive.~~

OK OK OK.

11/5/62

One diode had gone bad. Back current 15 μa giving a load resistance of about 100K Ω. Replace both diodes with new ones having 1.5 μa back current. The stage works satisfactorily again.

14/12/62



Gain in DB
100
90
80
70
60
50
40
30
20
10
0
Mixer Grid
Filter Output
First I.F. Grid
Second I.F. Grid
170
200
20
40
60
80
300
350
Kilocycles

Both I.F. Stages Together

Input 1st I.F. grid. Output 2 volts. E_c +12V

19/3/62

Gain versus Frequency

Freq. KC	Input mv	Gain DB			Input mv	Gain DB
150	20.0	40.0				
180	11.5	44.8				
200	3.0	56.5				
210	1.78	61.0				
220 222	1.46	62.7	1.45	62.8		
230	1.57	62.1				
240 244	1.78	61.0	1.81	60.9		
250	1.67	61.6				
260	1.56	62.2				
270 278	1.47	62.7	1.45	62.8		
280	1.46	62.7				
290	1.59	62.0				
300	2.2	59.2				
320	5.1	51.9				
350	14.2	43.0				
400						

Regulation at E_C = +12V

E_B Volts	157	166	175
I_X ma	2.05	2.10	2.15
Output %	-1.0	100	+1.0

For gain stabilizing versus change in B+
see 7/1/55 = ~~July 1st 55~~ 7 Jan 55
on sheets related to 3 stage amplifier.

attempts to reduce gain by operating with very small cathode current stop the gain stabilizing action.

also see 18/2/57 back of sheet on performance of last stage. This agrees with earlier tests.

apparently a 15K-Ω cathode resistor was used in both cases. about 0,6 ma cathode current seems to produce best stability against gain changes with changes in Plate & screen volts. This is about 9.0 volts from cathode to ground.