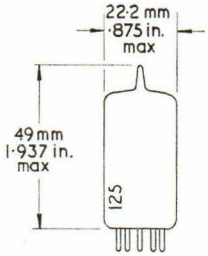
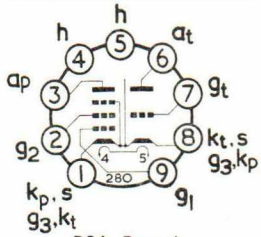


V.H.F. FREQUENCY CHANGER



GENERAL

This triode and variable mu pentode valve combination of frame grid construction is for use in television tuners. It is primarily intended to be used as a variable gain V.H.F. frequency changer with the triode as local oscillator but the pentode is also designed for use as a high gain controlled I.F. amplifier following a U.H.F. tuner.

Heater Current	I_h	0·3	A
Heater Voltage	V_h	7·4	V

RATINGS

		Pentode	Triode	
Maximum Anode Dissipation	$P_{a(max)}$	2 0	2·0	W
Maximum Screen Grid Dissipation	$P_{g2(max)}$	0·5	—	W
Maximum Anode Voltage	$V_{a(max)}$	250	250	V
Maximum Screen Grid Voltage	$V_{g2(max)}$	230	—	V
Maximum Heater to Cathode Voltage (R.M.S.)	$V_{h-k(r.m.s.)max}$	200	200	V
Maximum Cathode Current	$I_{k(max)}$	18	18	mA
Maximum Grid to Cathode Resistance (Fixed Bias)	$R_{g1(max)}$	250	500	kΩ

INTER-ELECTRODE CAPACITANCES

		*	†	‡	
Grid 1 to all	C_{g1-all}	6·5	7·2	8·1	pF
Anode Pentode to all	C_{ap-all}	2·8	3·0	4·0	pF
Grid 1 to Anode Pentode	C_{g1-ap}	·008	·01	·012	pF
Anode Triode to Earth	C_{at-E}	2·1	2·2	3·0	pF
Grid Triode to Earth	C_{gt-E}	3·3	3·4	4·2	pF
Anode Pentode to Grid Triode	C_{ap-gt}	·0015	·0025	·004	pF
Grid Triode to Anode Triode	C_{gt-at}	1·9	2·0	2·2	pF
Anode Pentode to Anode Triode	C_{ap-at}	·009	·012	·015	pF
Grid 1 to Grid Triode	C_{g1-gt}	·008	·016	·035	pF
Grid 1 to Anode Triode	C_{g1-at}	·003	·0065	·011	pF

* In fully-shielded socket with can (I.E.C. Publication 100).

† With holder capacity balanced out but with cylindrical screen can (Holder as below).

‡ Total capacity including ceramic B9A holder with cylindrical screen (Plessey holder type CP180024/3).

CHARACTERISTICS

		Pentode	Triode	
Anode Voltage	V_a	125	100	V
Screen Grid Voltage	V_{g2}	125	—	V
Control Grid Voltage	V_{g1}	−1·5	−3·2	V
Anode Current	I_a	10	15	mA
Screen Grid Current	I_{g2}	3	—	mA
Mutual Conductance	g_m	11	8·5	mA/V
Amplification Factor	μ	—	20	
Inner Amplification Factor	μ_{g1-g2}	45	—	

△ Shield completely surrounds pentode. The basing is arranged to minimise pentode cathode lead inductance effects with the shorter lead to pin 1.
The basing is identical to that of the 30C15/PCF800.

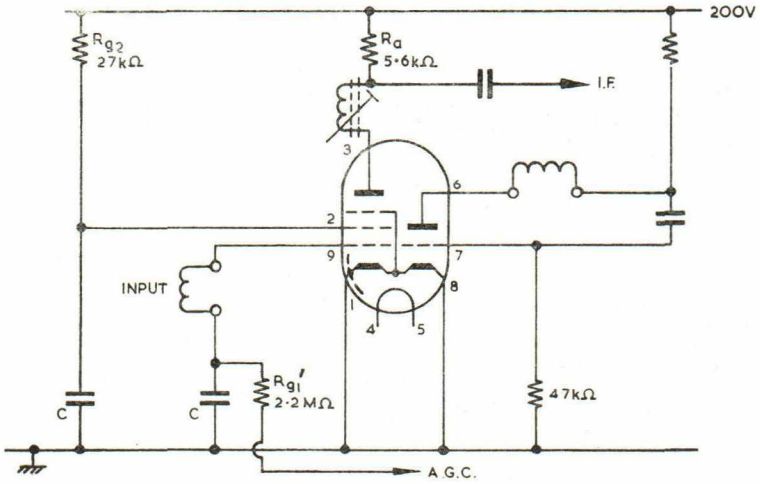
TYPICAL OPERATION AS FREQUENCY CHANGER AND I.F. AMPLIFIER

Grid current bias operation with A.G.C. Oscillator voltage injected into grid 1.

Pentode		F.C.	I.F.*	
Frequency	f	200	36	Mc/s
Supply Voltage	V_b	200	200	V
Anode Voltage (Decoupling Resistance, R_a=5·6k Ω) (approx.)	V_a	160	130	V
Screen Grid Voltage (R_{g2}=27k Ω) (approx.)	V_{g2}	150	100	V
Grid 1 Resistance	$R_{g1'}$	2·2	2·2	M Ω
Current through Grid 1 resistance	I_{g1}	1·3	0·3	μA
Anode Current (approx.)	I_a	7·3	12·5	mA
Screen Grid Current (approx.)	I_{g2}	1·8	3·7	mA
Conversion Conductance at 1 Mc/s (V_b,R_a,R_{g1},R_{g2} as above)	g_c	4·8	—	mA/V
Grid Voltage for Conversion Conductance reduction 10 : 1	$V_{g1(gc/10)}$	−6·5	—	V
Mutual Conductance (V_b,R_a,R_{g1},R_{g2} as above)	g_m	—	15	mA/V
Grid Voltage for Mutual Conductance reduction 10 : 1	$V_{g1(gm/10)}$	—	−4·8	V
Grid Voltage for Mutual Conductance reduction 100 : 1	$V_{g1(gm/100)}$	—	−6·6	V
Valve Input Resistance (Anode short circuited)	r_{g1}	—	11	k Ω
Working Input Capacitance	$c_{in(w)}$	—	11†	pF
Change in Input Capacitance by biasing valve to cut off	$\Delta c_{in(w)}$	—	2·7	pF
Triode				
Anode Voltage	V_a	60		V
Anode Current	I_a	7		mA
Rectified Grid Voltage (Grid Resistance = 47k Ω)	V_g	6		V

* Supply voltage removed from triode.

† With holder capacitance balanced out but with can.



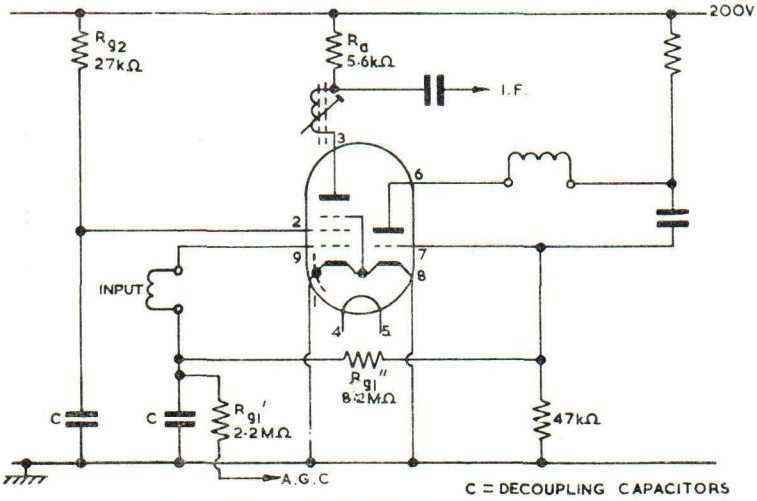
C = DECOUPLING CAPACITORS

TYPICAL OPERATION AS FREQUENCY CHANGER AND I.F. AMPLIFIER

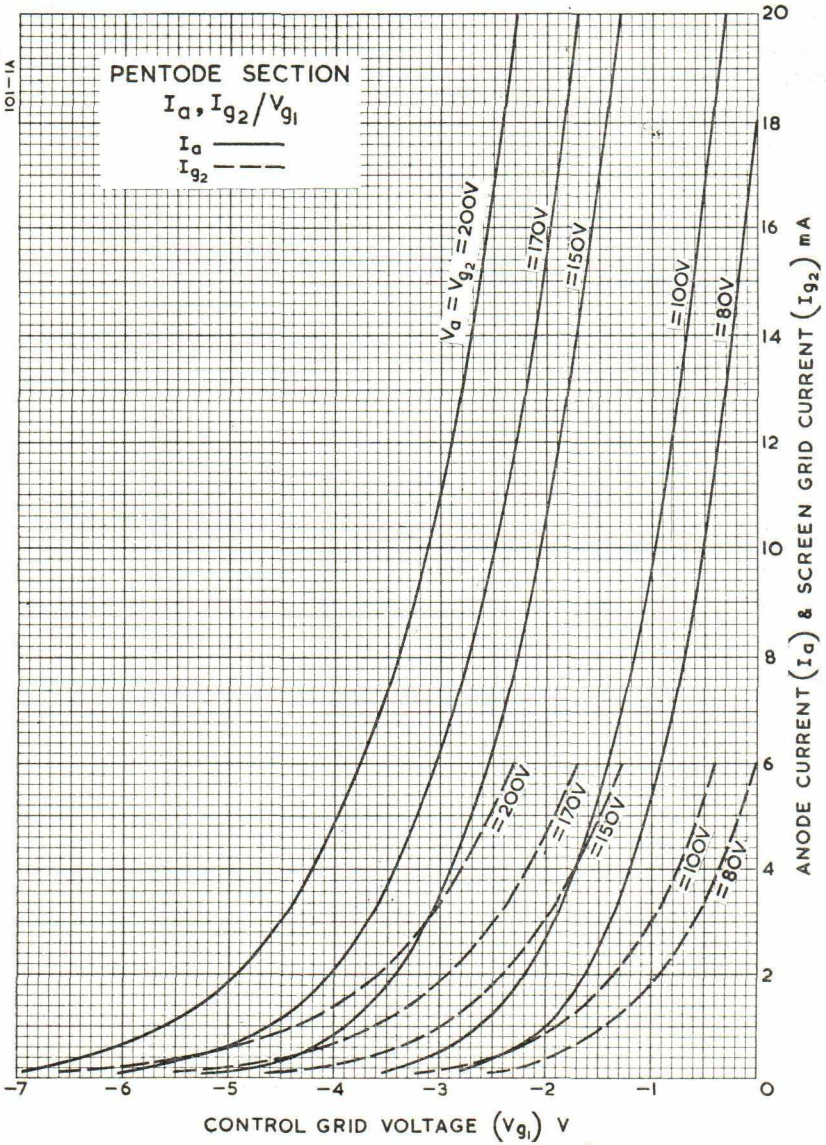
Partial grid current bias can be used for the frequency changer operation when a rectified voltage of greater than 8V d.c. is available from the triode grid resistor. This reduces the delay in the initial $V_{a.g.c.}/g_c$ characteristic as shown on page 10. The heterodyne voltage is injected into grid 1.

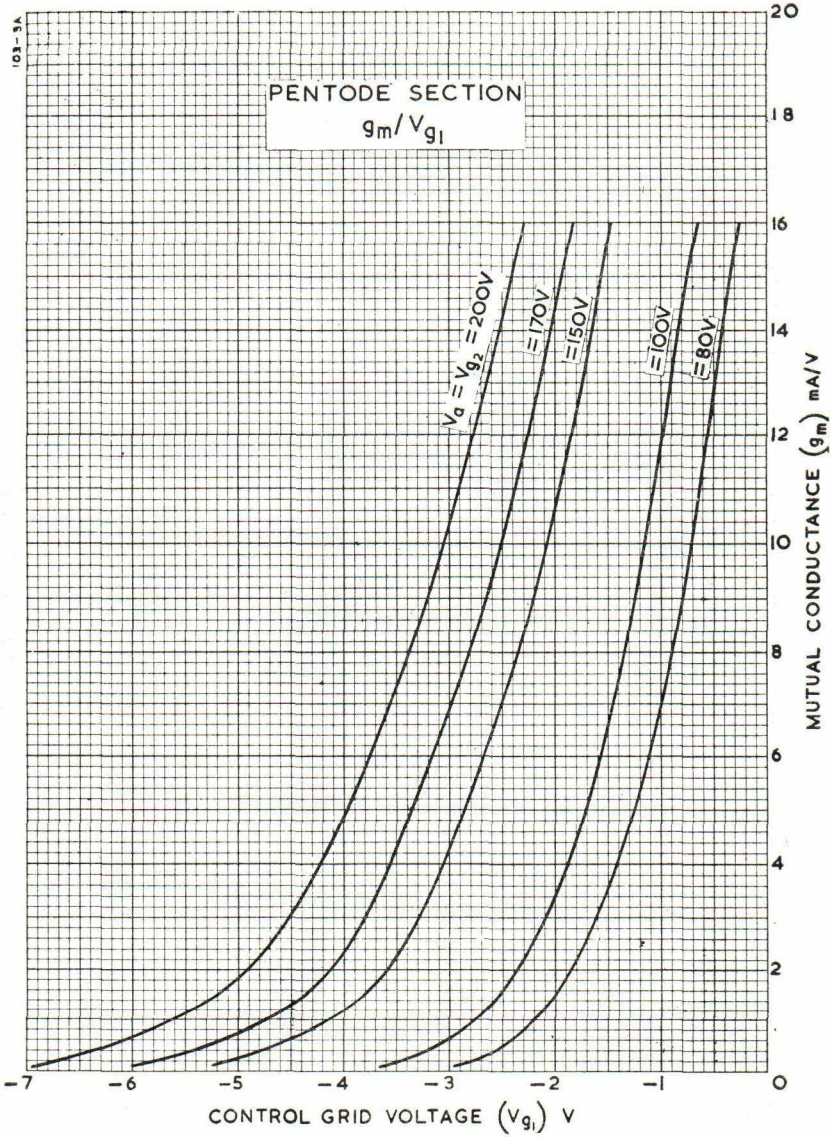
		F.C.	I.F.*	
Pentode				
Frequency	f	200	36	Mc/s
Supply Voltage	V_b	200	200	V
Anode Voltage (Decoupling Resistance, R_a=5·6k Ω) (approx.)	V_a	160	130	V
Screen Grid Voltage (R_{g2}=27k Ω) (approx.)	V_{g2}	150	100	V
Current through resistance $R_{g1'}$ ($R_{g1'}$=2·2M Ω)		1·8	0·3	μA
Resistance to provide bias from Triode Grid	$R_{g1''}$	8·2	8·2	M Ω
Anode Current (approx.)	I_a	7·3	12·5	mA
Screen Grid Current (approx.)	I_{g2}	1·8	3·7	mA
Conversion Conductance at 1 Mc/s (V_b,R_a,R_{g1},R_{g2} as above)	g_c	4·7	—	mA/V
Grid Voltage for Conversion Conductance reduction 10 : 1	$V_{g1(gc/10)}$	−5·4	—	V
Mutual Conductance (V_b,R_a,R_{g1},R_{g2} as above)	g_m	—	15	mA/V
Grid Voltage for Mutual Conductance reduction 10 : 1	$V_{g1(gm/10h)}$	—	−6	V
Grid Voltage for Mutual Conductance reduction 100 : 1	$V_{g1(gm/100)}$	—	−8·3	V
Valve Input Resistance (Anode short circuited)	r_{g1}	—	11	k Ω
Working Input Capacitance	$c_{in(w)}$	—	11†	pF
Change in Input Capacitance by biasing valve to cut off	$\Delta c_{in(w)}$	—	2·7	pF
Triode				
Anode Voltage	V_a	70		V
Anode Current	I_a	9		mA
Rectified Grid Voltage (Grid Resistance = 47k Ω)	V_g	11		V

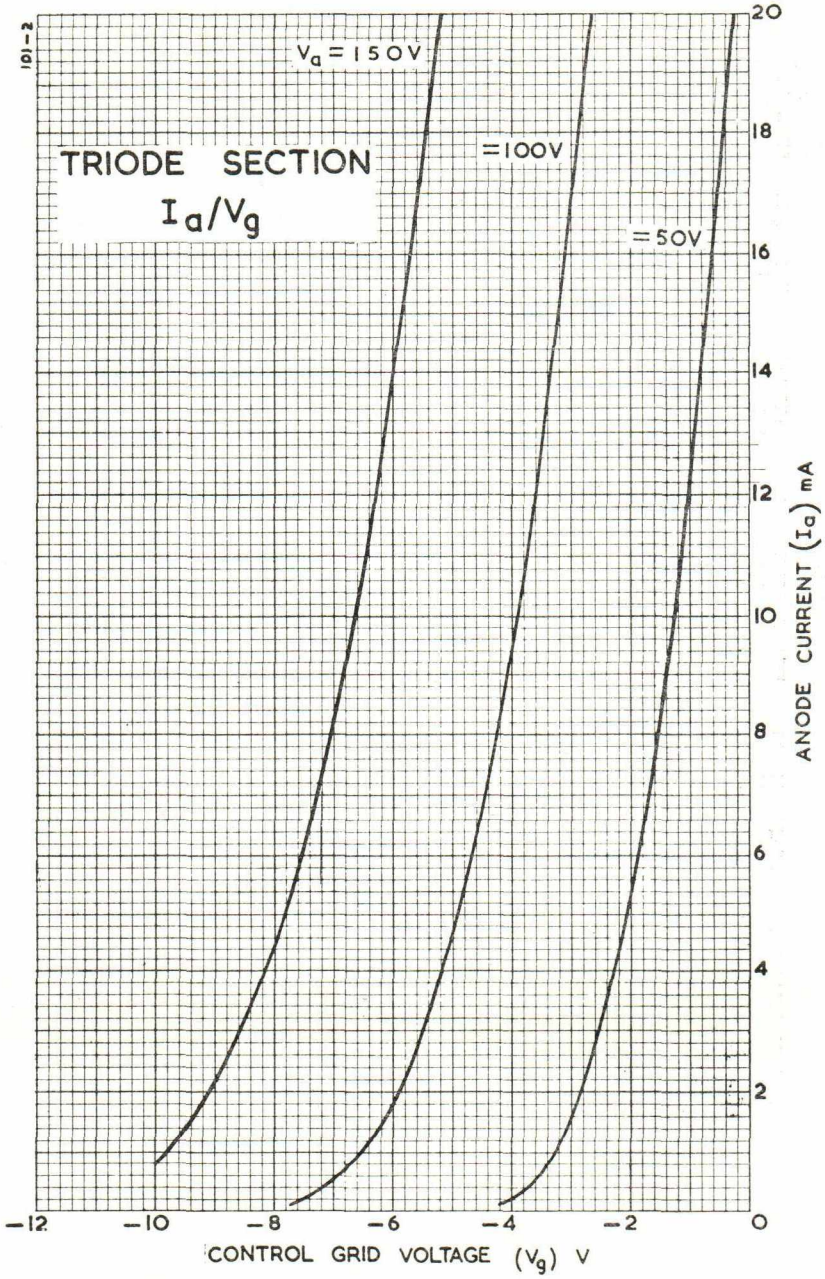
* Supply voltage removed from triode.
† With holder capacitance balanced out but with can.

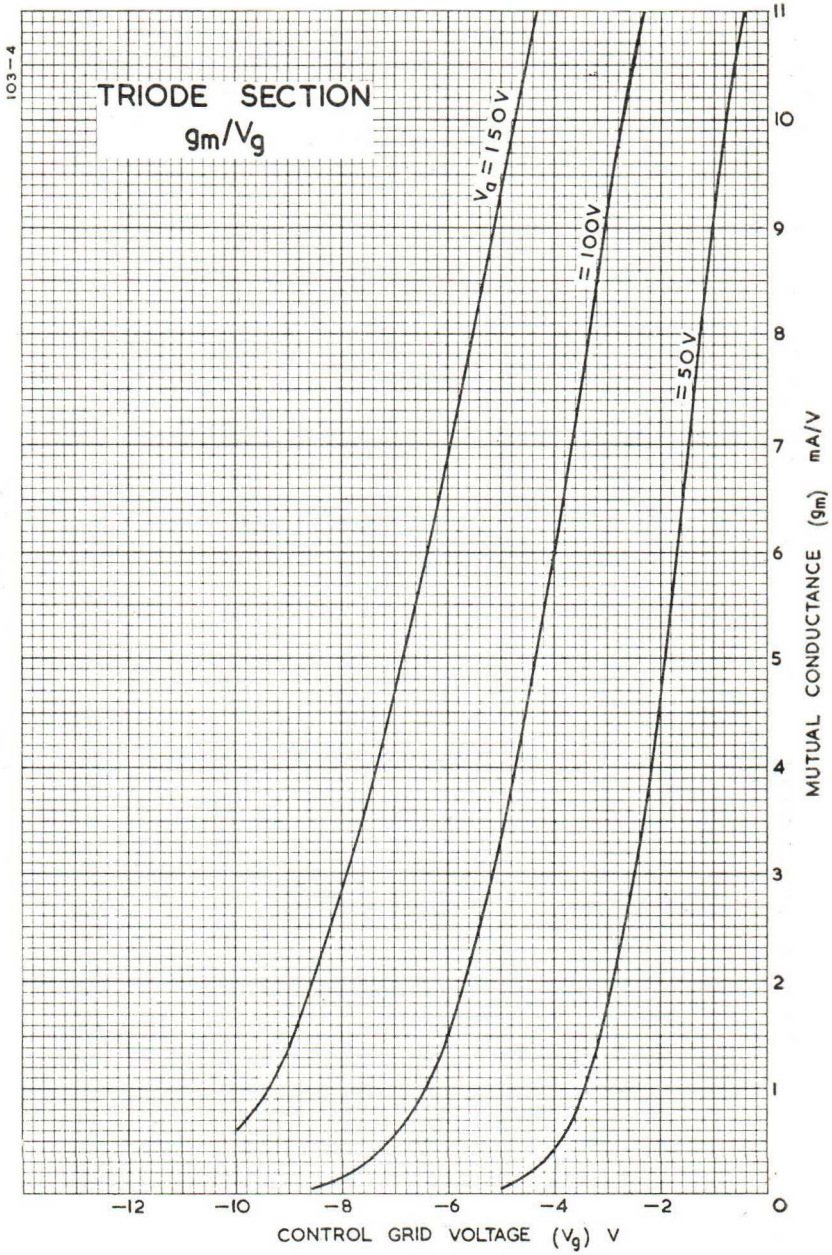


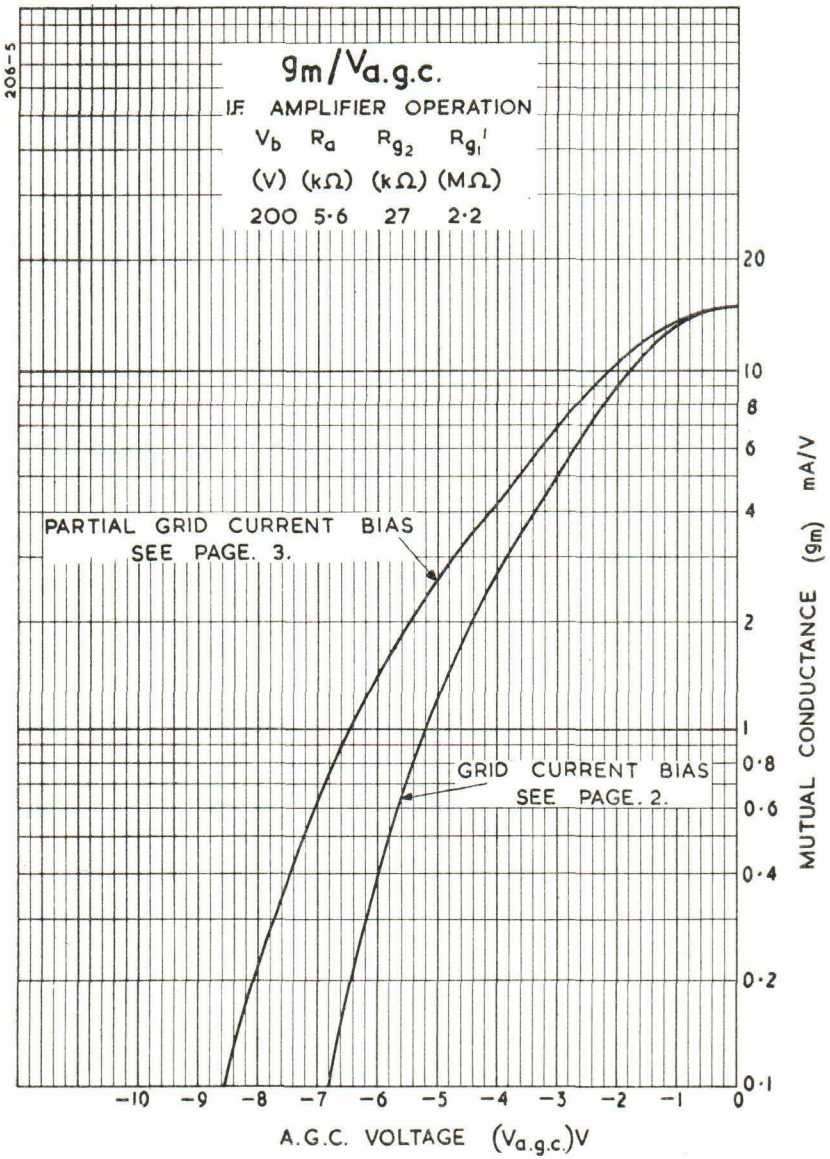
MOUNTING POSITION—Unrestricted

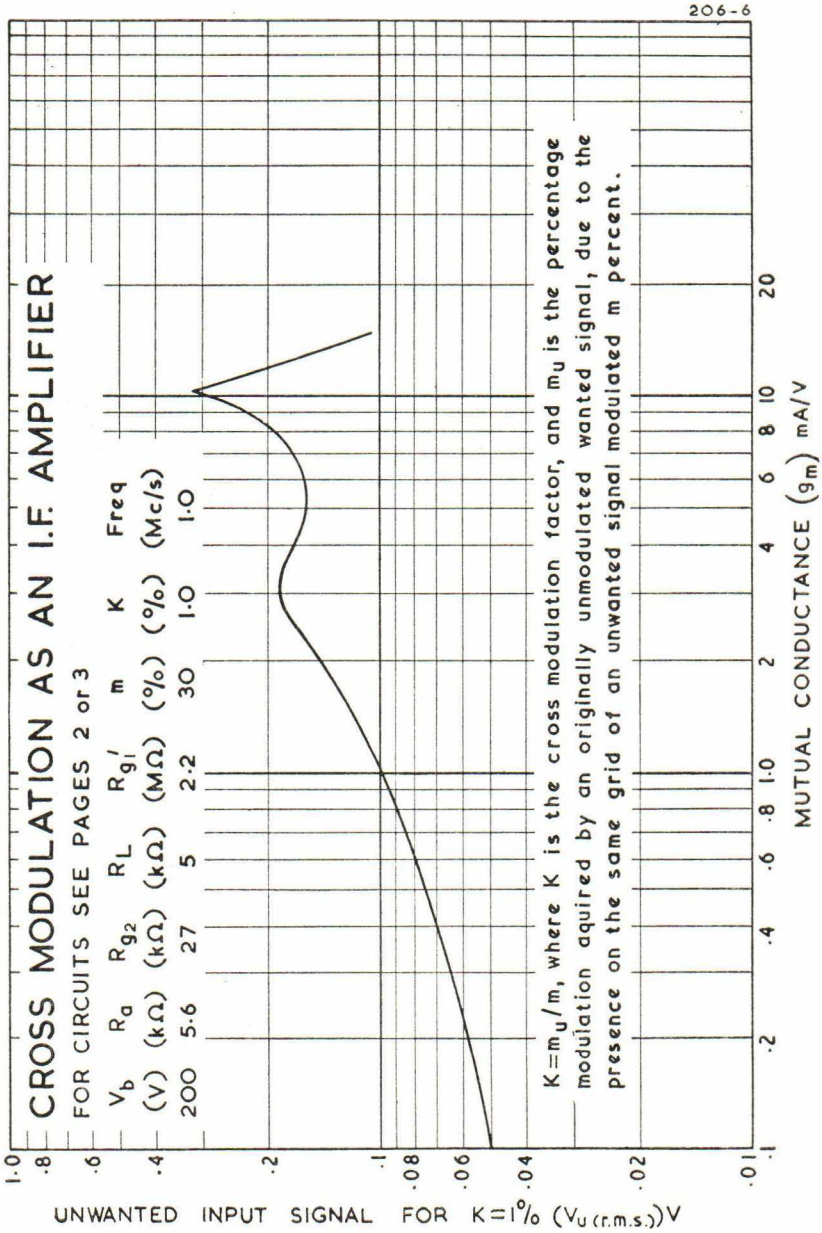

PENTODE SECTION
$I_a, I_{g_2}/V_{g_1}$
I_a
I_{g_2}
$V_a = V_{g_2} = 200V$
$= 170V$
$= 150V$
$= 100V$
$= 80V$
$= 200V$
$= 170V$
$= 150V$
$= 100V$
$= 80V$
ANODE CURRENT (I_a) & SCREEN GRID CURRENT (I_{g_2}) mA
CONTROL GRID VOLTAGE (V_{g_1}) V
20
18
16
14
12
10
8
6
4
2
0
−7
−6
−5
−4
−3
−2
−1

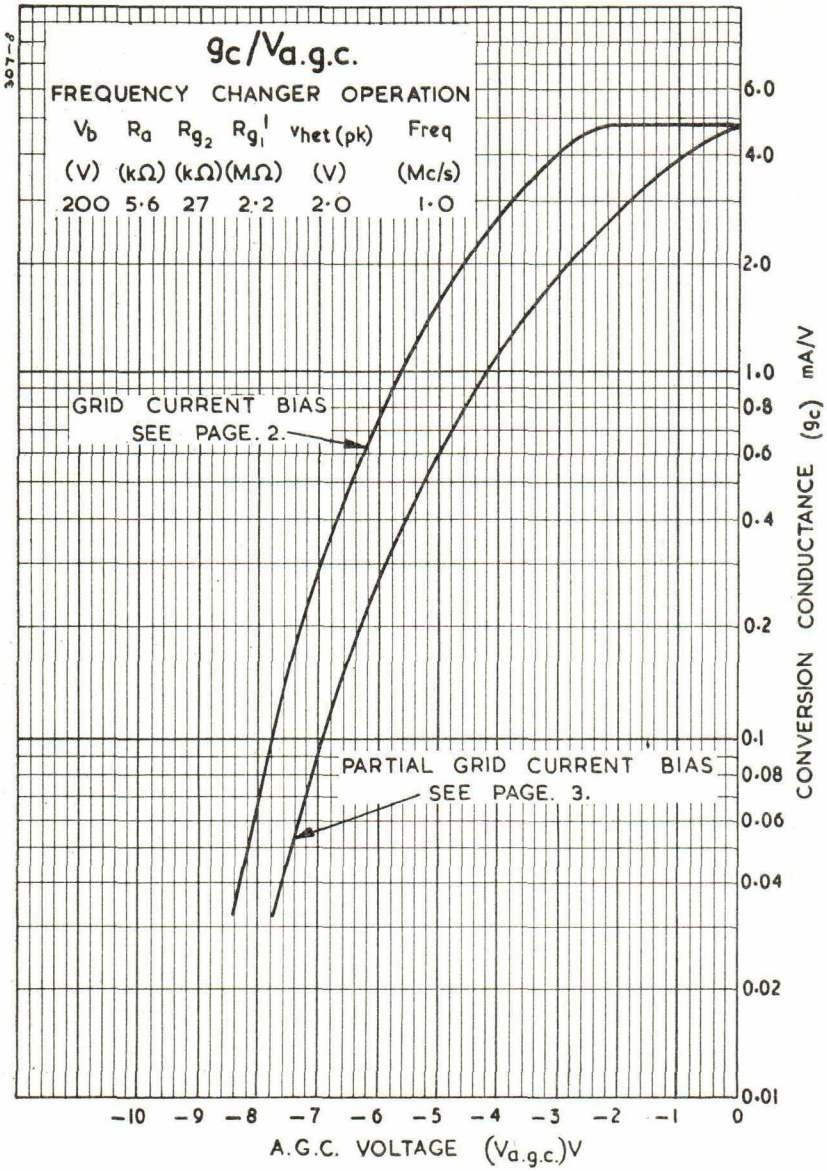

103-3A
PENTODE SECTION
gm/Vg1
Va = Vg2 = 200V
= 170V
= 150V
= 100V
= 80V
20
18
16
14
12
10
8
6
4
2
0
MUTUAL CONDUCTANCE (gm) mA/V
-7
-6
-5
-4
-3
-2
-1
CONTROL GRID VOLTAGE (Vg1) V

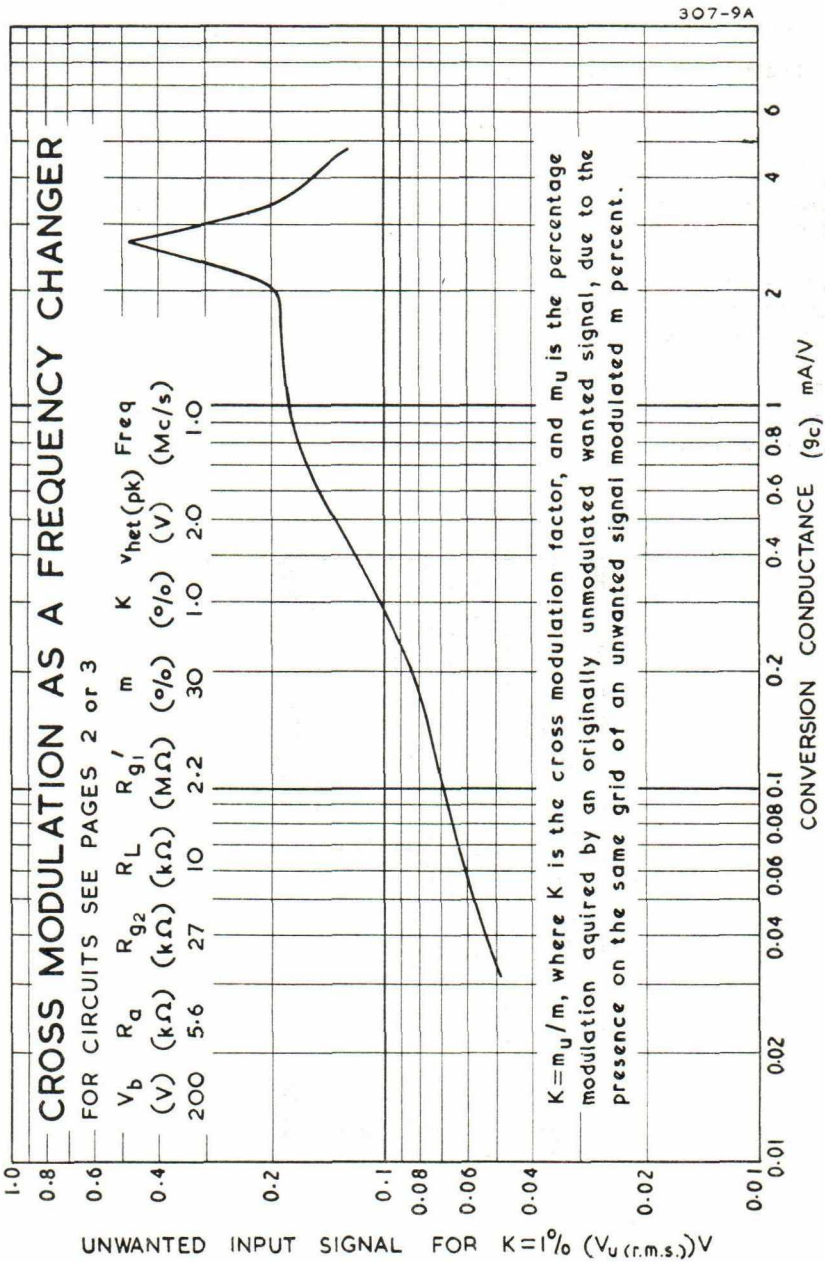

TRIODE SECTION
Ia/Vg
Va = 150V
=100V
=50V
20
18
16
14
12
10
8
6
4
2
0
ANODE CURRENT (Ia) mA
−12
−10
−8
−6
−4
−2
CONTROL GRID VOLTAGE (Vg) V


103-4
TRIODE SECTION
gm/Vg
Va = 150V
= 100V
= 50V
MUTUAL CONDUCTANCE (gm) mA/V
0
1
2
3
4
5
6
7
8
9
10
11
−12
−10
−8
−6
−4
−2
CONTROL GRID VOLTAGE (Vg) V


206-5
gm/Va.g.c.
I.F. AMPLIFIER OPERATION
Vb Ra Rg2 Rg1'
(V) (kΩ) (kΩ) (MΩ)
200 5·6 27 2·2
PARTIAL GRID CURRENT BIAS
SEE PAGE. 3.
GRID CURRENT BIAS
SEE PAGE. 2.
20
10
8
6
4
2
1
0·8
0·6
0·4
0·2
0·1
MUTUAL CONDUCTANCE (gm) mA/V
−10 −9 −8 −7 −6 −5 −4 −3 −2 −1 0
A.G.C. VOLTAGE (Va.g.c.)V


206-6
CROSS MODULATION AS AN I.F. AMPLIFIER
FOR CIRCUITS SEE PAGES 2 or 3
Vb (V) 200
Ra (kΩ) 5·6
Rg2 (kΩ) 27
RL (kΩ) 5
Rg1' (MΩ) 2·2
m (%) 30
K (%) 1·0
Freq (Mc/s) 1·0
K=mu/m, where K is the cross modulation factor, and mu is the percentage modulation aquired by an originally unmodulated wanted signal, due to the presence on the same grid of an unwanted signal modulated m percent.
UNWANTED INPUT SIGNAL FOR K=1% (Vu (r.m.s.))V
MUTUAL CONDUCTANCE (gm) mA/V
1·0
·8
·6
·4
·2
·1
·08
·06
·04
·02
·01
·1
·2
·4
·6
·8
1·0
2
4
6
8
10
20


307-8
gc/Va.g.c.
FREQUENCY CHANGER OPERATION
Vb Ra Rg2 Rg1' vhet(pk) Freq
(V) (kΩ) (kΩ) (MΩ) (V) (Mc/s)
200 5·6 27 2·2 2·0 1·0
GRID CURRENT BIAS
SEE PAGE. 2.
PARTIAL GRID CURRENT BIAS
SEE PAGE. 3.
6·0
4·0
2·0
1·0
0·8
0·6
0·4
0·2
0·1
0·08
0·06
0·04
0·02
0·01
CONVERSION CONDUCTANCE (gc) mA/V
−10 −9 −8 −7 −6 −5 −4 −3 −2 −1 0
A.G.C. VOLTAGE (Va.g.c.)V

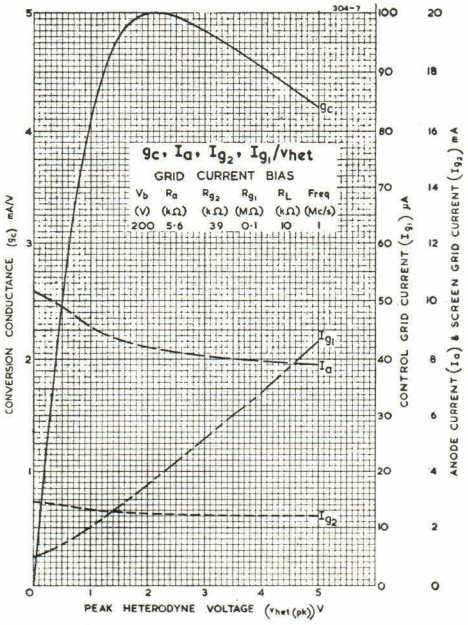

307-9A
CROSS MODULATION AS A FREQUENCY CHANGER
FOR CIRCUITS SEE PAGES 2 or 3
Vb (V) 200
Ra (kΩ) 5·6
Rg2 (kΩ) 27
RL (kΩ) 10
Rg1' (MΩ) 2·2
m (%) 30
K (%) 1·0
vhet(pk) (V) 2·0
Freq (Mc/s) 1·0
K=mu/m, where K is the cross modulation factor, and mu is the percentage modulation aquired by an originally unmodulated wanted signal, due to the presence on the same grid of an unwanted signal modulated m percent.
UNWANTED INPUT SIGNAL FOR K=1% (Vu (r.m.s.))V
CONVERSION CONDUCTANCE (gc) mA/V
1·0
0·8
0·6
0·4
0·2
0·1
0·08
0·06
0·04
0·02
0·01
0·01
0·02
0·04
0·06
0·08
0·1
0·2
0·4
0·6
0·8
1
2
4
6

TYPICAL OPERATION AS FREQUENCY CHANGER AT 200Mc/s

Grid current bias operation without A.G.C. Oscillator voltage injected into grid 1.

Pentode

Supply Voltage	Vb	200	V
Anode Voltage (Decoupling Resistance, $R_a = 5{\cdot}6k\Omega$)	V_a	155	V
Screen Grid Voltage ($R_{g2} = 39k\Omega$)	V_{g2}	108	V
Grid 1 Resistance	R_{g1}	0·1	MΩ
Grid 1 Current	I_{g1}	24	μA
Anode Current (approx.)	I_a	8·1	mA
Screen Grid Current (approx.)	I_{g2}	2·4	mA
Conversion Conduction at 1 Mc/s ($v_{het(pk)} = 2{\cdot}8V$)	g_c	4·9	mA/V

Triode

Anode Voltage	V_a	100	V
Anode Current	I_a	5	mA