Transmitting Tubes

RCA TUBE
HANDBOOK
HB-3

TRANSMITTING TUBE SECTION

This Section contains data on vacuum power tubes, rectifier tubes, magnetrons, and other tube types used in broadcast, television, and communications transmitters, as well as in other types of electronic equipment handling appreciable power.

For further Technical Information, write to Commercial Engineering, Tube Division, Radio Corporation of America, Harrison, N. J.

VACUUM-POWER-TUBE SERVICE

TYPICAL OPERATION POWER OUTPUT APPROX. WATTS	RCA TYPE
Class A Amplifiers, AF	
0.6	5556
3.8	801A
3.9	2E24
30	845
Class AB1 Amplifiers, AF[b]	
15[a]	807
15[a]	1625
22[a]	6146
22[a]	6146W
22[a]	6159
22[a]	6159W
22[a]	6883
22[a]	8032
–	7870
–	7801
40[a]	2E26
44	829B
56[a]	807
56[a]	1625
80	6816
80	6884
80	7457
80	7842
80	7843
80	7844
80	8596
82[a]	6146
82[a]	6146A
82[a]	6146W
82[a]	6159
82[a]	6159W
82[a]	6883
82[a]	8032
96[e]	6146B/8298A
96[e]	6159B
96[e]	6883B/8032A/8552
–	8165/4-65A
115	845
190[c]	7271
300[c]	828
–	6155
380[c]	813
410[c]	7094
–	4-125A/4D21

TYPICAL OPERATION POWER OUTPUT APPROX. WATTS	RCA TYPE
–	4E27A/5-125B
580	7034/4X150A
590	7203/4CX250B
590	7204/4CX250F
–	6156
–	4-250A/5D22
–	8438/4-400A
800	8167/4CX300A
1600	7650
–	8166/4-1000A
–	8168/4CX1000A
–	8239/3X3000F1
–	8170/4CX5000A
31,900	8171/4CX10000D
57,000	8281/4CX15000A
Class AB2 Amplifiers, AF[b]	
40[c]	6524
40[c]	6850
42[c]	2E24
42[c]	2E26
42[c]	815
72	1624
80[c]	807
80[c]	1625
90[c]	6146
90[c]	6146A
90[c]	6146W
90[c]	6159
90[c]	6159W
90[c]	6883
90[c]	8032
110[c]	6146B/8298A
110[c]	6159B
110[c]	6883B/8032A/8552
140	6816
140	6884
140	7457
140	7842
140	7843
140	7844
140	8596
–	6155
–	4-125A/4D21
–	4E27A/5-125B
630	7034/4X150A

VACUUM-POWER-TUBE SERVICE (Cont'd)

TYPICAL OPERATION — POWER OUTPUT APPROX. WATTS	RCA TYPE
–	6156
–	4-250A/5D22
Class B Amplifiers, AF[b]	
45	801A
235[c]	811A
235[c]	812A
250[c]	8005
590[c]	810
600[c]	8000
1640	5786
1650[c]	833A
2400[c]	833A
8800	5762/7C24
10,000	891R
10,500	892R
15,000	889A
15,000	889RA
22,000	892
22,500	207
46,000	880
50,000	9C25
55,000	5771
61,000	9C21
100,000	5671
117,000	5770

TYPICAL OPERATION — POWER OUTPUT APPROX. WATTS	TYPICAL OPERATION — FREQ. MHz	RCA TYPE
Class B Amplifiers, RF Telephony		
–	3000	7801
–	3000	7870
–	30	5556
5.5	20	837
7.5	60	801A
10.5[a]	125	815
12.5[a]	60	807
12.5[a]	60	1625
20	100	834
36[e]	30	828
40[e]	60	8005
50[e]	30	813
–	120	6155
60[a]	30	810
65[a]	30	8000
–	75	6156
150[a]	30	833A
225[a]	20	833A
400	110	827R
1800	1.6	892R
2000	50	889A
2000	40	889RA
4000	1.6	207
4000	1.6	892
9000	25	880
12,000	1.6	5771
Class B Amplifiers, Television Service		
230	900	6161
250	216	7034/4X150A
300	890	4624
440	216	7203/4CX250B
440	216	7204/4CX250F
–	220	4X500A
1200	900	6181
2800	220	6076
6350	216	5762/7C24
5500	890	8501
12,000	216	6166
12,000	800	6448
14,000	216	6166A/7007
19,000	800	6806
Class C Amplifiers, Plate-Modulated RF Telephony		
1.7	3000	7801
1.7	3000	7870
–	6	5556
9[a]	462	6524
9[a]	462	6850
11	20	837
13.5[a]	125	2E24
13.5[a]	125	2E26
17[a]	200	832A
17	400	7801
17	400	7870

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VACUUM-POWER-TUBE SERVICE (Cont'd)

TYPICAL OPERATION		RCA TYPE
POWER OUTPUT APPROX. WATTS	FREQ. MHz	
18	60	801A
24	60	1624
28[a]	60	807
28[a]	60	1625
30[a]	125	815
34[a]	60	6146
34[a]	60	6146A
34[a]	60	6146W
34[a]	60	6159
34[a]	60	6159W
34[a]	60	6883
34[a]	60	8032
42[a]	60	6146B/8298A
42[a]	60	6159B
42[a]	60	6883B/8032A/8552
–	2500	2C39A
–	2500	2C39WA
–	2500	6897
45	400	6816
45	400	6884
45	400	7457
45	400	7842
45	400	7843
45	400	7844
45	400	8596
50[a]	200	8298
58	100	834
70[a]	200	8298
85[a]	30	812A
88[a]	30	811A
90[a]	60	7271
–	150	8165/4-65A
100[a]	30	828
115[a]	60	8005
120	900	6161
180[a]	60	7094
180[a]	30	813
230	150	7034/4X150A
235	175	7203/4CX250B
235	175	7204/4CX250F
235	175	8167/4CX300A
250[a]	30	810
250[a]	30	8000
–	125	6155
–	75	6156

TYPICAL OPERATION		RCA TYPE
POWER OUTPUT APPROX. WATTS	FREQ. MHz	
600	400	7650
635	30	833A
800	600	4618
800	600	7213
810	160	5786
825	110	827R
950	400	6181
1000	20	833A
–	110	8438/4-400A
–	1000	8166/4-1000A
2700	110	6076
4000	50	889A
4000	40	889RA
–	30	8170/4CX5000A
4200	30	5762/7C24
4500	900	6448
5000	1.6	892R
5500	60	6166
5800	30	8171/4CX10000D
6000	1.6	207
6000	1.6	892
6000	60	6166A/7007
10,000	400	6806
18,000	30	9C25
27,000	25	880
29,000	1.6	5771
38,000	5	9C21
40,000	1.6	5671
45,000	20	5770
Class C Amplifiers, Grid-Modulated RF Telephony		
5.5	20	837
8	60	1624
10.5[a]	125	815
36[a]	30	828
50[a]	30	813
65[a]	30	8000
400	110	827R
Class C Amplifiers, Suppressor-Modulated RF Telephony		
5	20	837
–	75	4E27A/5-1258

VACUUM-POWER-TUBE SERVICE (Cont'd)

TYPICAL OPERATION		RCA TYPE
POWER OUTPUT APPROX. WATTS	FREQ. MHz	
Class C Amplifiers, Television Service		
230	900	6161
1200	900	6181
4000	216	5762/7C24
5300	216	8D21
12,000	216	6166
12,000	216	6166A/7007
Class C Amplifiers, RF Telegraphy and FM Telephony		
3.2	3000	7801
3.2	3000	7870
–	30	5556
–	3370	2C40
–	3370	2C40A
–	1500	2C43
–	2500	2C39A
–	2500	2C39WA
–	2500	6897
20[a]	125	2E24
20[a]	125	2E26
22	20	837
25	60	801A
26	200	832A
27	400	7801
27	400	7870
30[d]	175	4604
35	60	1624
40	60	807
40	60	1625
40	1215	6816
40	1215	6884
40	1215	7457
40	1215	7842
40	1215	7843
40	1215	7844
40	1215	8596
44[a]	125	815
46[a]	100	6524
46[a]	100	6850
52[a]	60	6146
52[a]	60	6146A
52[a]	60	6146W/7212
52[a]	60	6159

TYPICAL OPERATION		RCA TYPE
POWER OUTPUT APPROX. WATTS	FREQ. MHz	
52[a]	60	6159W/7357
52[a]	60	6883
52[a]	60	8032
63[a]	60	6146B/8298A
63[a]	60	6159B
63[a]	60	6883B/8032A/8552
70	200	8298
75	100	834
85	470	8072
85	470	8462
80	400	8596
90[a]	200	829B
105	1215	8226
130[a]	30	812A
135[a]	30	811A
–	150	8165/4-65A
150	30	828
160	60	7271
170	60	8005
180	900	6161
225	500	8167/4CX300A
235	470	8121
250	500	7203/4CX250B
250	500	7204/4CX250F
255[a]	60	7094
275[a]	30	813
300	470	8122
325	220	5713
340	400	8226
370	150	7034/4X150A
375[a]	30	810
375[a]	30	8000
–	120	6155
–	120	4-125A/4D21
–	75	4E27A/5-125B
375	1215	7650
600	900	6181
1000[a]	20	833A
1000	160	5786
–	75	6156
–	75	4-250A/5D22
–	110	8438/4-400A
–	120	4X500A
1050	110	827R

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VACUUM-POWER-TUBE SERVICE (Cont'd)

TYPICAL OPERATION: POWER OUTPUT APPROX. WATTS	TYPICAL OPERATION: FREQ. MHz	RCA TYPE
1350	600	4618
1350	600	7213
1440[a]	30	833A
–	110	8166/4-1000A
–	30	8170/4CX500A
2300	890	4632
5500	900	8501
6500[a]	300	8D21
7000	30	5762/7C24
9000	216	6166
10,000	400	8437
10,000	50	889A
10,000	50	889RA
10,000	1.6	891R
10,000	1.6	892R
10,000	216	6166A/7007
11,000	900	6448
13,500	900	6806
14,000	1.6	892
15,000	1.6	207
16,000	30	8178/4CX10000D
32,500	30	9C25
36,500	110	8281/4CX15000A
40,000	25	880
44,000	25	5771
70,000	1.6	5671
100,000	5	9C21
114,000	20	5770
500,000	0.425	6949, 6949VI
Class C Amplifiers or Oscillators Self-Rectifying		
175[e]	27	811A[f]
200[e]	27	812A
225	30	813
330[e]	50	8005
550[e]	30	8000
835[a]	20	833A
1050	160	5786
1150	30	833A
3350	30	5762/7C24
Class C Amplifiers or Oscillators with Separate Plate Supply		
135	30	811A[f]
280	30	812A[f]
280	30	813
330[e]	27	8005
600[d]	30	8000
1100[a]	30	833A
1150	160	5786
1460	30	833A
5650	30	5762/7C24
CW Oscillator (Magnetron)		
30,000	915	8684
Linear RF Amplifiers Single-Sideband Suppressed Carrier—Two-Tone Modulation		
40	30	7457
40	30	8596
49[a]	30	6146B/8298A
49[a]	30	6159B
49[a]	30	6883B/8032/8552
80	30	8072
80	30	8462
95[a]	60	7271
120	30	811A
170	30	8121
295	30	7203/4CX250B
295	30	7204/4CX250F
380	30	8122
400	175	8167/4CX300A
410	30	4624
680	30	7650
5000	30	4628
25,000	550	6806
600,000	10	6949, 6949VI
Linear RF Amplifiers, Single-Sideband Suppressed Carrier—Single-Tone Modulation		
–	3000	7801
–	3000	7870
40	60	6816
40	60	6884
40	60	7457
40	60	7842

VACUUM-POWER-TUBE SERVICE (Cont'd)

TYPICAL OPERATION: POWER OUTPUT APPROX. WATTS	TYPICAL OPERATION: FREQ. MHz	RCA TYPE
40	60	7843
40	60	7844
41	60	6146A
120	60	811A
95	60	7271
210	60	7094
250	150	7034/4X150A
295	175	7203/4CX250B
295	175	7204/4CX250F
680	30	7650
1250	60	4618
1250	60	7213
-	30	8168/4CX1000A
-	30	8170/4CX5000A
10,600	60	6166
12,000	60	6166A/7007
12,000	550	6448
600,000	10	6949, 6949V1
Linear RF Amplifiers, AM Telephony		
2000	400	4628
2500	400	4635
Linear RF Amplifiers-Particle Acceleration		
kW		
300	475	4612
Plate-Pulsed Amplifiers or Oscillators		
-	3370	2C40A
4.5	1215	7649
14	1250	5946
17	1215	4621
17	1215	8227
39	1215	7651
65	1215	7214
-	500	8184
180	450	2041
300	450	2041
500	440	2054
1500	200	6950
1500	50	4603
1500	50	4603V1
2000	425	6952
2000	425	8587

TYPICAL OPERATION: POWER OUTPUT APPROX. kW	TYPICAL OPERATION: FREQ. MHz	RCA TYPE
2000	425	4616
2000	425	4616V1
2500	440	2054
5000	250	7835
8000	425	4617
10,000	250	7835
Pulsed Oscillator (Klystron)		
21,000	2586	8568
Grid-Pulsed Amplifiers or Oscillators		
2.3	1215	7649
10	1215	4621
10	1215	8227
20	1215	7651
20	1215	7214
100	450	2041
180	450	2041
275	425	4616, 4616V1
1200	30	4603, 4603V1
RF-Frequency Multipliers		
WATTS		
7[a]	Tripler to 462	6524
7[a]	Tripler to 462	6850
140	Doubler to 900	6161
180	Doubler to 600	6161

TYPICAL OPERATION: PEAK POWER OUTPUT APPROX.	TYPICAL OPERATION: PULSE LENGTH μs	RCA TYPE
Pulse Modulators		
3.4 kW	100	6293
40 kW	1.2	3E29
-	-	4610

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VACUUM-POWER-TUBE SERVICE (Cont'd)

PEAK PLATE AMPERES	RCA TYPE
Voltage Regulators	
0.5	3C33
0.5	4614
1	4600A

RECTIFIERS

MAX. PLATE RATINGS		RCA TYPE
PEAK AMPERES	AVERAGE AMPERES	
Half-Wave, Mercury-Vapor Types[g]		
0.5	0.125	816
1	0.25	866A
2	0.5	866A
5	1.25	872A
5	1.25	8008
6	1.5	575A
6	1.5	673
8.3	1.8	6894
8.3	1.8	6895
10[g]	2.5[g]	575A
10[g]	2.5[g]	673
10	2.5	615/7018
10	2.5	8698
15	2.5	5558
11.5[h]	2.5[g]	6894
11.5[h]	2.5[g]	6895
16	4	5561
20[a]	5[a]	8698

MAX. PLATE RATINGS		RCA TYPE
PEAK AMPERES	AVERAGE AMPERES	
77	6.4	635/7019
40	6.4	5561
40	10	8578
Full-Wave, Mercury-Vapor Types[f]		
10	2.5	604/7014
Half-Wave, Gas Type[g]		
1	0.25	3828
2	0.5	3828
Half-Wave, Vacuum Types[g]		
0.04	0.002	5825
0.06	0.0075	2X2A
0.15	0.02	8013A
0.27	0.25	5798
0.75	0.1	8020
0.8	0.13	1616
1	0.25	836

[a] Intermittent Commercial and Amateur Service.
[b] Typical power output is for two tubes, except for twin-unit types.
[c] Not recommended as Oscillator in this class of service.
[d] Intermittent Commercial and Amateur Service only.
[e] Two tubes.
[f] Not recommended as Oscillator in this class of service.
[g] In phase operation, unless otherwise specified.
[h] Quadrature operation.

* FOR DETAILED DATA ON TYPES NOT LISTED IN THESE CHARTS, REFER TO INDIVIDUAL DATA SHEETS IN THE TRANSMITTING TUBE SECTION

These charts are arranged in three parts:
1 & 2 - Data   3-Terminal Diagrams

PART 1

DATA

POWER TUBES FOR CW APPLICATIONS (Unless Otherwise Specified[a])

RCA Type	Description	Cooling	Filament Heater		Maximum Ratings						
					Plate			Grid No 2		Grid No 1	
			Volts	Amp	Volts	A	Dissip Watts	Volts	Watts	Volts	mA (Watts)
2C39A	Lighthouse Triode	Forced Air	6.3	1.0	1000	.125	100	–	–	-150	50
2C39WA	Lighthouse Triode-Hi Temp	Forced Air	5.8	1.0	Ref.	MIL-E-1/778E -------------------					
2C40	Lighthouse Triode, Hi Freq	Natural	6.3	0.75	450	.022	5.0	–	–	–	–
2C43	Lths Tri Hi Plate Dis	Natural	6.3	0.90	450	.036	10	–	–	–	–
2E24	Quick Heat, Beam Power	Natural	6.3	0.65	600	.085	13.5	200	2.5	-175	3.5
2E26	Beam Pwr Pentode	Natural	6.3	0.80	600	.085	13.5	200	2.5	-175	3.5

RCA Electronic Components

RCA TRANSMITTING TUBE DATA 1

PART 1 (CONT'D)

RCA Type	Description	Cooling	Filament Heater		Maximum Ratings						
					Plate			Grid No 2		Grid No 1	
			Volts	Amp	Volts	A	Dissip Watts	Volts	Watts	Volts	mA (Watts)
3C33[a]	Twin Triode	Natural	12.6	1.125	2000 Peak	500 Peak .120 DC	15 each of two units	–	–	-200	7.5 IN
3E29[a]	Twin Beam Power Tube	Natural	6.3/ 12.6	2.25/ 1.125	5750 Peak 5000 DC	10^b Peak	15^b	850	3^b IN	-225	1^b IN
					Max on: 12 μs		b. both units in parallel. Max Int: 1200 μs				
4-125A/ 4D21	Beam Power Tetrode	Forced Air	5.0	6.5	3000	.225	125	400	20	-500	5W
4-250A/ 5D22	Beam Power Tetrode	Forced Air	5.0	14.5	4000	.350	250	600	35	-500	5W
4E-27A/ 5-125B	Beam Power Pentode	Natural	5.0	7.5	4000	.200	125	750	20	-500	10W
4X500A	Beam Power Tetrode	Forced Air	5.0	13.5	4000	.350	500	500	30	-500	50^cW
8D21	Twin Tetrode	Water	3.2	125	6000	5.0	6000^c	1000	400^c	-1000	650
807	Power Pentode	Natural	6.3	0.90	750	.100	30	300	3.5	-200	5

a. Type 3C33 for Pulse Regulator Applications. Type 3E29 for Pulse Modulator Applications.
c. Two Tubes.

PART 1 (CONT'D)

RCA Type	Description	Cooling	Filament Heater		Maximum Ratings						
					Plate			Grid No 2		Grid No 1	
			Volt	Amp	Volts	A	Dissip Watts	Volts	Watts	Volts	mA (Watts)
810	Hi Mu Triode	Natural	10.0	4.5	2000	.250	125	–	–	-500	75
813	Hi Gain Beam Power	Natural	10.0	5.0	2250	.225	125	400	22	-300	30
827R	Beam Power Tube	Forced Air	7.5	25	3500	.500	800	1000	150	-500	150
828	Low Freq Pentode	Natural	10	3.25	2000	.150	80	750	23	–	–
829B	Twin Beam Power	Forced Air	6.3	2.25	750	.240	45	250	8	-175	20
830B	Low Freq Triode	Natural	10.0	2.0	1000	.150	60	–	–	-300	30
832A	Twin Beam Pwr Tube	Natural	6.3	1.6	750	.090	15	250	5	-100	6
834	VHF Triode	Natural	7.5	3.1	1250	.100	50	–	–	-400	20
837	Low Freq Pentode	Natural	12.6	0.7	500	.080	12	200	8	-200	8

PART 1 (CONT'D)

RCA Type	Description	Cooling	Filament Heater		Maximum Ratings						
					Plate			Grid No 2		Grid No 1	
			Volts	Amp	Volts	A	Dissip Watts	Volts	Watts	Volts	mA (Watts)
845	Triode	Natural	10.0	3.25	1250	.120	100	–	–	-400	–
860	Tetrode	Natural	10.0	3.25	3000	.150	100	500	10	-800	40
880	Triode	Water	12.6	320	10500	6.0	20k	–	–	-1200	800
891R	Lo Freq Triode	FA[d]	22.0	60	10000	2.0	4k	–	–	-3000	150
892	Lo Freq Triode	Water	22.0	60	15000	2.0	10k	–	–	-3000	400
892R	Lo Freq Triode	FA	22.0	60	12500	2.0	4k	–	–	-3000	400
1624	Beam Power Tube	Natural	2.5	2.0	600	.090	25	300	3.5	-200	5
1625	Beam Power Tube	Natural	12.6	0.45	750	.100	30	300	3.5	-200	5
5556	Lo Freq Triode	Natural	4.5	1.1	350	.040	10	–	–	-150	10

d. Forced Air.

PART (CONT'D)

RCA Type	Description	Cooling	Filament Heater		Maximum Ratings						
					Plate			Grid No 2		Grid No 1	
			Volts	Amp	Volts	A	Dissip Watts	Volts	Watts	Volts	mA (Watts)
5713	Power Triode	FA	3.3	11.5	1500	.30	250	–	–	-250	50
5786	Compact Triode	FA	11.0	12.5	3000	0.5	600	–	–	-500	150
6146 [e]	Hi Eff Beam Pwr Tube	Natural	6.3	1.25	750	.150	25	250	3	-150	4.0
6155	Beam Power Tube	FA	5.0	6.5	3000	.225	125	400	20	-500	15
6156	Beam Power Tube	FA	5.0	14.1	4000	.350	250	600	35	-500	20
6159	Glass Beam Power Tube	Natural	26.5	0.3	750	.150	25	250	3	-150	4.5
6181	UHF Power Tetrode	FA	120	1.55	2000	1.25	2000	500	40	-300	200
6883 [f]	Beam Power Tube	Natural	12.6	0.62	750	.150	25	250	3	-150	4.0
6897	Lighthouse Triode	FA	6.3	1.0	1000	125	100	–	–	-150	50
7271	Beam Power Tube	Natural	13.5	1.25	1350	.340	80	425	20	-300	30

[e] *For later version of this type refer to 6146B/8298A data sheets, located in the TRANSMITTING TUBE SECTION.*

[f] *For later version of this type refer to 6883B/8032A/8552 data sheet, located in the TRANSMITTING TUBE SECTION.*

PART 1 (CONT'D)

RCA Type	Description	Cooling	Filament Heater		Maximum Ratings						
					Plate			Grid No 2		Grid No 1	
			Volts	Amp	Volts	A	Dissip Watts	Volts	Watts	Volts	mA (Watts)
8000	Triode	Natural	10.0	4.5	2500	.300	175	–	–	-500	45
8005	Power Triode	Natural	10.0	3.25	1750	.125	75	–	–	-125	25
8032	Beam Power Tube Glass	Natural	13.5	0.58	750	.150	25	250	3.0	-150	4.0
8165/ 4-65A	VHF Power Tetrode	Natural	6.0	3.5	3000	.150	65	400	10	-500	5W
8166/ 4-1000A	VHF Power Tetrode	FA	7.5	21	6000	.700	1000	1000	75	-500	25W
8168/ 4CX1000A	Radial Beam Tetrode	FA	6.0	10.5	3000	1.0	1000	400	12	-60	–
8170/ 4CX5000A	Beam Power Tube	FA	7.5	75	7500	3.000	5000	1500	250	–	75W
8239/ 3X3000F1	Lo Mu Triode	FA	7.5	52	6000	2.500	3000	–	–	–	50W
8438/ 4-400A	Radial Tetrode Beam	FA	5.0	14.5	4000	.350	400	600	35	-500	10W

RCA TRANSMITTING-TUBE TYPES- Limited Listing

RCA Type	Prime Service	Amplification or Mu	Max Freq MHz	Physical			Typical Operation		
				Ht In	Dia In	Wt Oz	Freq MHz	Input (mA) Watts	Output Watts
2C39A	UHF Amp	100	2500	2-3/4	1-1/4	2	500	6	40
2C39WA	UHF Amp	–	–	2-3/4	1-1/4	2	–	–	–
2C40	UHF Amp	36	3370	2-9/16	1-5/16	2	–	–	–
2C43	UHF Amp	48	1500	2-11/16	1-5/16	2	–	–	–
2E24	Mobile	7.5	125	3-5/8	1-5/16	3	125	0.2	27
2E26	Hi Power Amp	6.5	125	3-1/2	1-5/16	3	125	0.17	27
3C33	Regulator	11	–	3-1/2	2-3/8	–	–	–	–
3E29	Modulator	9	–	4-1/8	2-3/8	3.5	Pulse: 1.2 μs Duty: .001 %		

PART 2 (CONT'D)

RCA Type	Prime Service	Amplification or Mu	Max Freq MHz	Physical			Typical Operation		
				Ht In	Dia In	Wt Oz	Freq MHz	Input (mA) Watts	Output Watts
4-125A/4D21	VHF Amp	6.2	120	5-1/2	2-7/8	6	120	2.5	375
4-250A/5D22	Hi Pwr VHF Amp	5.1	75	6-1/8	3-1/2	8	75	2.5	1000
4E-27A/5-125B	Hi Pwr Amp	5	75	6	2-3/4	6	75[c]	0.9[c]	375[c]
4X500A	Hi Pwr Amp	6.2	120	4-1/2	2-5/8	28	110	18	1180
8D21	VHF Osc Amp	5	300	12	5-3/4	–	300	500[c]	6500[c]
807	VHF Amp	8	60	5-3/4	2-1/16	3	60	.3	54
810	Hi Gain VHF Amp	36	30	8-1/2	2-1/8R	–	30	19	575
813	VHF Amp	8.5	30	7-1/2	2-9/16	8	30	4.0	375
827R	FM & VHF TV	16	110	6-3/8	4-5/8R	72	110	50	1050

c. Two Tubes.

PART 2 (CONT'D)

RCA Type	Prime Service	Amplification or Mu	Max Freq MHz	Physical			Typical Operation		
				Ht In	Dia In	Wt Oz	Freq MHz	Input (mA) Watts	Output Watts
828	Audio Amp	–	30	7-7/16	2-1/16	–	AF	0	385
829B	VHF Amp	9	200	4-1/8	2-3/8	–	200	0.8	115
830B	RF Amp	25	15	6-11/16	2-1/16	–	15	7	90
832A	VHF Amp	6.5	200	3-3/16	2-5/16	–	200	0.19	26
834	RF Amp	10.5	100	6-7/8	2–11/16	–	100	4.5	75
837	RF Amp	–	20	5-3/4	2-1/16	–	20	0.4	22
845	Modulator	5.3	AF	7-7/8	2-5/16	–	AF	–	115
860	VHF Amp	200	30	8-3/4	4-1/4R	–	30	7	165

RCA Electronic Components

PART 2 (CONT'D)

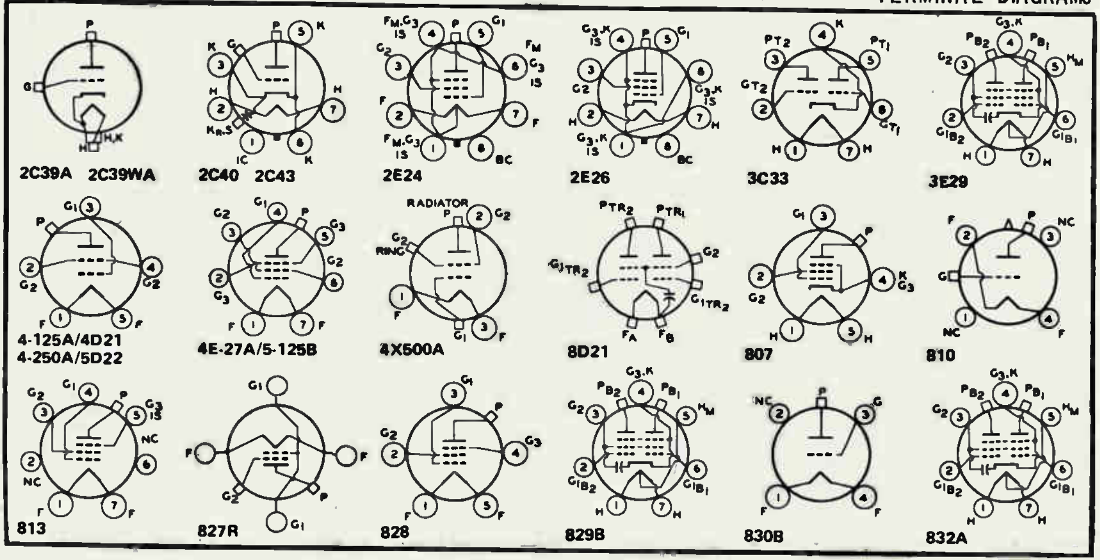
RCA Type	Prime Service	Amplification or Mu	Max Freq MHz	Physical			Typical Operation		
				Ht In	Dia In	Wt Oz	Freq MHz	Input (mA) Watts	Output Watts
880	VHF Amp	20	25	11-1/2	7	–	1.5	1500	40k
891R	RF Amp	8.5	1.6	2	6R	–	1.6	310	10k
892	RF Osc	50	1.6	20-1/8	5-9/16R	–	1.6	565	14k
892R	RF Osc	50	1.6	22	6R	–	1.6	495	10k
1624	UHF Amp	–	60	5-3/4	2-1/16	–	60	0.43	35
1625	Freq Mult	8	60	5-3/4	2-1/16	–	60	0.2	50
5556	Lo Freq Triode	8.5	6	5-5/8	2-3/16	–	6	0.25	6.0
5713	VHF Amp	25	220	4-25/32	2-1/16	–	220	8	290
5786	Industrial	32	160	9-3/8	2-7/8	1-1/2 lb	160	36	1000

PART 2 (CONT'D)

RCA Type	Prime Service	Amplification or Mu	Max Freq MHz	Physical			Typical Operation		
				Ht In	Dia In	Wt Oz	Freq MHz	Input (mA) Watts	Output Watts
6146A	Amateur	4.5	60	3-3/16	1-21/32	2.3	60	0.2	70
6155	RF Amp	6.2	120	5-3/32	2-7/16	3	120	2.0	375
6156	RF Amp	5.1	75	5-29/32	3-7/16	6	75	3.4	1000
6159	RF Amp	4.5	60	3-13/16	1-21/32	2.3	60	0.2	52
6181	UHF TV	8	900	7-7/16	5	5 lb	900	150	600
6883	RF Amp	4.5	60	3-13/16	1-9/16	2	60	0.2	70
6897	UHF Amp	–	2500	2-3/4	1-1/4	2	500	–	40
7271	RF Amp	8	60	4.75	2.00	3.5	60	90	225

PART 2 (CONT'D)

RCA Type	Prime Service	Amplification or Mu	Max Freq MHz	Physical			Typical Operation		
				Ht In	Dia In	Wt Oz	Freq MHz	Input (mA) Watts	Output Watts
8000	VHF Amp	16.5	30	8-1/2	2-1/8R	–	30	18	575
8005	Oscillator	20	60	6-7/16	5-7/8	–	60	8.5	220
8032	Mobile RF Amp	4.5	60	3-13/16	1-21/32	2.3	60	0.2	70
8165/4-65A	RF Amp	5	50	4-3/16	2-3/8	3.0	50	1.7	280
8166/4-1000A	RF Amp	7	110	9-1/4	5-1/4	1.5 lb	110	15	3400
8168/4CX1000A	Lin RF Amp	–	110	4-3/4	3-3/8	27	–	–	1680
8170/4CX5000A	RF Amp	4.5	30	9-1/8	4-15/16	9.5 lb	–	–	–
8239/3X3000F1	AF Amp	4.8	–	10-1/2	4-3/16	7-1/2 lb	–	0	10k
8438/4-400A	RF Amp	5.1	110	6-3/8	3-9/16	9.0	75	5.8	1100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2C40 2C43
2E24
2E26
3C33
3E29
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4-250A/5D22
4E-27A/5-125B
4X500A
8D21
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810
813
827R
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829B
830B
832A

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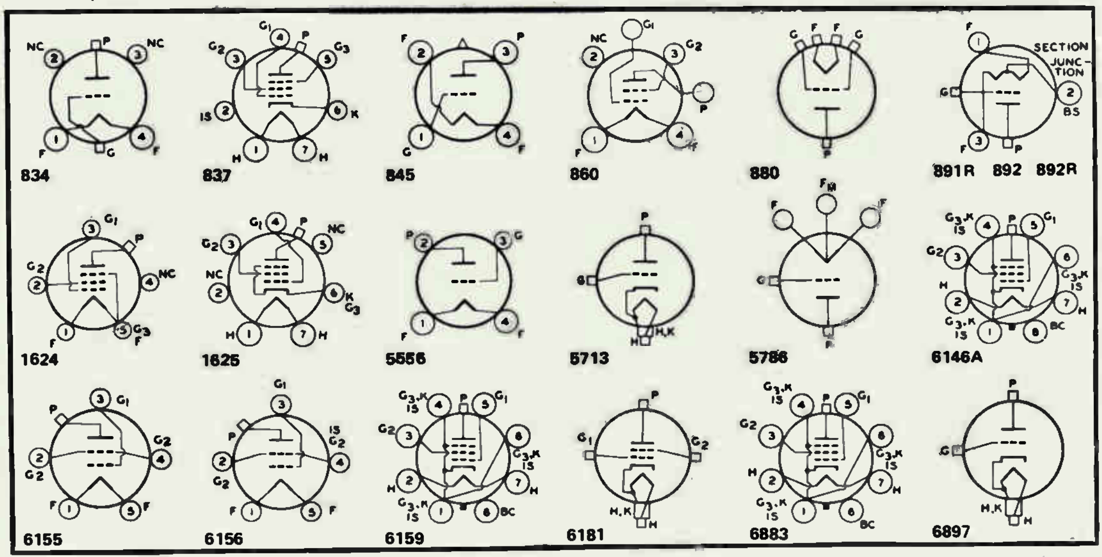
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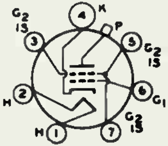

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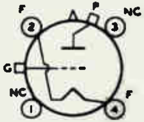

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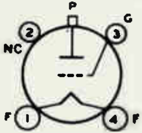

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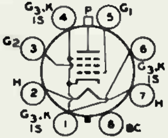

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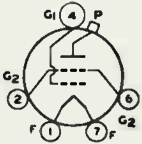

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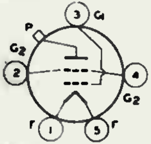

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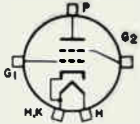

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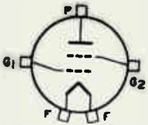

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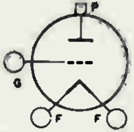

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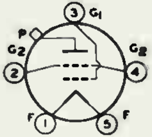

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RCA Transmitting Tube Operating Considerations

The following operating considerations for RCA transmitting tubes are intended for use with the data sheets on individual tube types given in the Handbook. Operating considerations unique to a particular tube type are not included in this presentation but are covered by the Handbook data sheets for the given type.

RATINGS

Refer to the *General Section* of the Handbook for a detailed discussion on Rating Systems and Tube Ratings.

CLEANING

As with other high-voltage equipment, it is essential that external parts of power tubes be kept free from accumulated dirt and moisture to minimize surface leakage and the possibility of arc-over.

Some tube configurations contain re-entrant areas at the edge of the insulator seals. Particular care should be taken to prevent foreign matter from coming in contact with these areas. Unless adequately protected by filtered air, these areas collect dirt rapidly as a result of electrostatic forces and the nature of the air circulation around the tube.

The external parts of the tube should periodically be wiped free of dirt. A recommended procedure for cleaning ceramic-metal tubes is as follows:

1. Remove silicone grease or similar material by use of acetone, or equivalent.

   Caution: Do not allow silicone grease or similar materials to remain on any rf contact surfaces. Severe burning of the contact surfaces of cylindrical-terminal types will occur if the contact fingers do not mate firmly with clean metal contact surfaces.

2. Clean rf contact surfaces with a very fine grade of silicon carbide abrasive pad, or equivalent.

   Caution: Do not permit the cleaning pad to come in contact with the ceramic surfaces. Rub gently to prevent removal of plating.

COOLING CONSIDERATIONS

Tube life can always be extended by maintaining envelope temperatures substantially below the maximum temperature ratings.

The user is cautioned that typical cooling characteristics in the published data are offered only as a guide, and that maximum envelope temperatures in the intended operation are the final rating criteria.

Temperature measurements of the tube envelope must be made to insure operation within maximum ratings. For glass-bulb types, the bulb "hot-spot" must be located with the tube operating in its intended application. A simple technique for locating the "hot-spot" in low-power, receiving-type tubes is to apply a low-temperature-melting paint, such as Tempilaq[a], to the entire bulb surface; the point at which this material first begins to melt is the hottest point on the bulb. For most power tubes, however, this technique is not satisfactory because of radiation effects. Therefore, it is recommended that a thermocouple be moved over the envelope to locate the hottest point on the bulb. (Although the individual thermocouple readings are not precise, the relative readings are sufficient.) Spots of various higher temperature Tempilaq paints may then be applied only to the hottest area; the lowest Tempilaq paint which will not melt must be at or below the maximum temperature rating. See Ref. 1. In general, the hottest point of a ring terminal is at the seal or junction of the terminal and its adjacent glass or ceramic insulator. For some tube types the temperature measurement points are specified on the *Dimensional Outline* in the published data.

All types of heat transfer—radiation, convection, conduction, and combinations thereof—are employed in the various cooling techniques: natural, forced-air, liquid, and conduction cooling.

Natural Cooling—This method is generally used for glass-bulb types having plate dissipation ratings up to about 300 watts.

Temperature should be measured at the hottest point on the bulb using techniques previously discussed.

Adequate free space around the tube is required for all natural cooled types. Avoid reflective heat surfaces such as tube shields. These and other design considerations affecting natural methods of cooling are described in Ref.2.

Forced-Air Cooling—

Glass-Bulb-Types—Forced-air cooling may be applied to glass-bulb types to enhance the convection cooling and reduce bulb temperature. In some glass-bulb types, ratings are given for both natural and forced-air cooling. (The ratings with forced-air cooling reflect the higher permitted value of dissipation.) In general, any natural-cooled type may require some forced-air cooling if operation is near the maximum ratings or if limited space is available around the tube. The final decision can be made only after temperature measurements are made to insure operation below the maximum temperature rating.

Radiator Types—The external plate construction lends itself to compactness, higher frequency operation, increased power capability, and intense-cooling techniques. Because the plate is part of the envelope, transfer of heat by radiation from the plate to the envelope is eliminated. The simplest intense-cooling technique is forced-air. All RCA forced-air-cooled, external-plate types contain integral radiators, which are brazed, pressed, or otherwise secured to the plate to insure intimate thermal contact.

Most of the heat within an electron tube is generated at the plate; additional heat generated from the other electrodes migrates to the plate. Precaution, however, must be taken to insure that none of the other terminals exceed their maximum rated temperature value. It may be necessary to direct some forced air across these terminals.

In general, there are two basic types of radiators: the stacked-disc type of finned radiator for TRANSVERSE FORCED-AIR COOLING, and the radial-fin type of radiator for AXIAL FORCED-AIR COOLING.

Transverse Cooling—Air flow is directed across the radiator from an orifice in a plane normal to the major axis of the tube and at the center of the radiator. More efficient cooling may be accomplished by providing a cowling to direct and confine the air. Pressure drop across the radiator itself is normally insignificant. Typical cooling characteristics for transverse cooling, such as shown in Fig.1, are given in the published data. The following steps illustrate the use of the chart:

1. Estimate probable *Plate Dissipation* from electrical conditions, locate as point "A" on the abscissa axis (80 watts in example), and erect a perpendicular line "ac".
2. Determine temperature rise by subtracting estimated incoming-air temperature (assume 36°C in example) from estimated

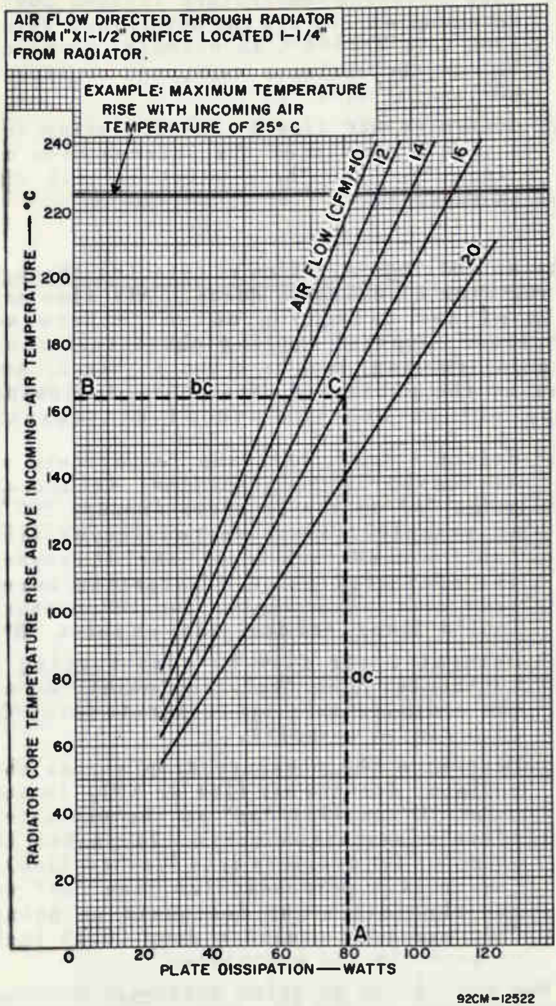

FIG.1 - EXAMPLE OF TYPICAL COOLING CHARACTERISTICS

tube operating temperature (assume 200°C in example), locate the determined value (200°C-36°C=164°C in example) as point "B" on the ordinate axis, and construct horizontal line "bc".

3. Determine air flow by interpolating the air flow curves at the intersection of lines "ac" and "bc", point "C" (16 cfm in example).

Axial Cooling—Air flow is directed through the radiator by suitable ducts. Air flow may be in either direction unless otherwise specified. Typical cooling characteristics for axial cooling, such as shown in Fig.2, are given in the published data. The following steps illustrate the use of the chart:

1. Select a tube operating temperature as discussed in this section, locate as point "A" on the abscissa (assume 200°C in example), erect perpendicular line "ab", extend this line until it crosses the estimated plate dissipation curve (240 watts in example) for temperature (solid line), and designate as point "B".
2. Determine air flow by constructing a horizontal line "bc" from point "B" to the ordinate axis and designate point "C" (3.5 cfm in example).
3. Determine the pressure drop across the radiator for the air flow in (2), locate point "D" on line "bc" at the estimated plate dissipation curve (240 watts in example) for pressure drop (dashed line), construct a perpendicular line "de" to the abscissa axis, designate as point "E", and read pressure drop (0.24 inch of water in the example).

See Ref. 3 for detailed information on the blower requirements for forced-air-cooled tubes.

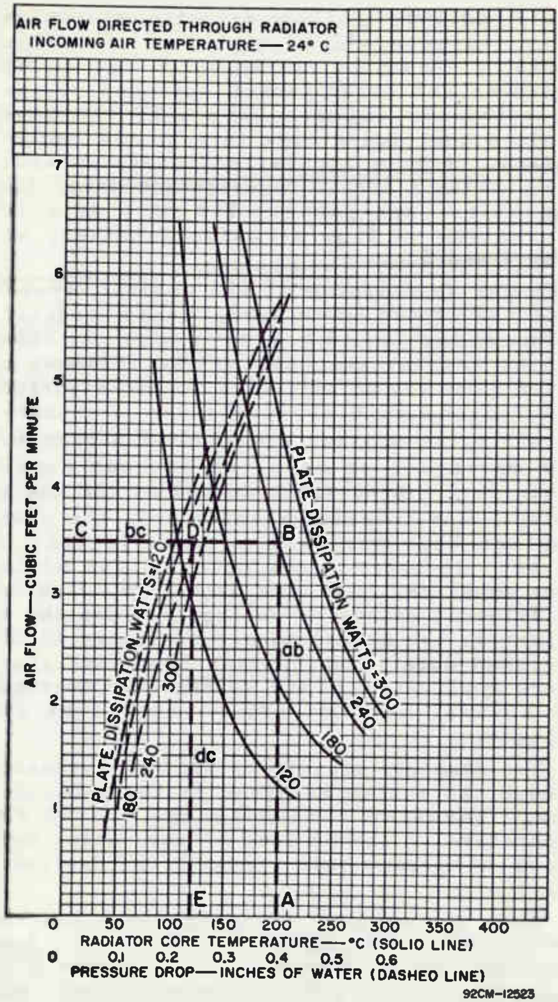

FIG.2 - EXAMPLE OF TYPICAL COOLING CHARACTERISTICS

Liquid Cooling—The liquid-cooling system consists, in general, of a source of cooling liquid, a feed-pipe system which carries the liquid to the water jacket surrounding, and provision for interlocking with the power supplies the liquid flow through the cooling courses. A more sophisticated system would also contain a liquid regeneration loop, flow regulators, and gages. For more detailed information on liquid-cooling systems, see Refs. 4 and 5.

Proper functioning of the coolant system is of the utmost importance. Even a momentary failure of the liquid flow may damage the tube. Without coolant the heat of the filament or heater alone may be sufficient to cause serious harm to some tube types. It is necessary, therefore, to provide a method of preventing tube operation in case the coolant supply should fail. A suitable method is the use of coolant-flow interlocks which open the power supplies when the flow is insufficient or ceases. If there is an interruption of the power supplies, it is then necessary to return the filament or heater voltage to zero and to restart in the normal manner described in the published data. The coolant flow must start before application of any voltage and continue for several seconds after removal of all voltages.

The absolute minimum coolant flow required through the system is given in the published data. Under no circumstances should the temperature of the coolant at any outlet ever exceed the maximum value given in the published data.

When the coolant fluid is water and the tube is used in equipment under conditions such that the ambient temperature is below 0°C, precautions should be taken to prevent the water from freezing in the system.

Use of Water as Coolant—For availability and ease in handling, water is recommended as the coolant wherever possible. It is of utmost importance to maintain a high quality of water in the cooling system. Contamination in the water will hasten scale formation, corrosion, and excessive electrolysis; any one of these conditions can greatly reduce tube life.

Use of Liquids other than Water as Coolant—When ambient temperatures fall below 0°C, it is possible to use coolants such as ethylene-glycol-water solution and FC75[b]. Neither of these two coolants is as effective a coolant as water, therefore, the plate dissipation and flow data must be modified from that given for water. A more extensive discussion of ethylene-glycol-water solution and FC75 as coolants is given in Ref.4. For information on the use of any coolant for which ratings are not given in the data, contact your RCA field representative or the nearest District Sales Office. A coolant such as oil will require a special plating on the metal of the tube envelope, such as nickel and rhodium to protect the metal surfaces from chemical attack.

Conduction Cooling—The conduction-cooling system consists, in general, of a constant temperature device (heat sink) and suitable heat-flow path (coupling) between the heat sink and tube. Primary consideration of the system should be given to the design of a heat-flow path (coupling device) with high thermal conductivity.

Heat Sink—The heat sink should be designed to act as a constant-temperature device to prevent any increase in temperature by dissipating the heat beyond the equipment compartment. Heat sinks can take the form of solids or liquids. In most applications such a heat sink is available in the form of equipment chassis, plate line, or output cavity.

Coupling—There are numerous insulating materials available to serve as the heat-coupling device, such as beryllium oxide (beryllia)[c], high-aluminum oxide (high-alumina), mica, and other insulating bodies. Since the thermal conductivity of these insulators varies considerably, the choice of insulator will depend primarily on the plate dissipation in the given application. For a detailed discussion on conduction cooling, see Ref. 6.

In hf operation the inductive element of the plate circuit is usually a relatively long coil, which does not provide a good thermal path from plate to chassis. Larger shunt capacity can be tolerated, however, and heat can be conducted through a portion of it to the chassis. In uhf operation the permissible shunt capacity of the plate circuit is limited, but the inductive element is short and can usually be made with sufficient cross-sectional area to form an excellent thermal path. In vhf operation a careful compromise of the above is required to obtain adequate rf performance and reasonable cooling.

PRECAUTIONS

The voltages at which power tubes are operated are extremely dangerous. Protection circuits must be provided which will protect operation and maintenance personnel, protect the tube in the event of abnormal circuit operation, and protect the tube circuits in the event of abnormal tube operation. Power tubes require mechanical protective devices such as interlocks, relays, and circuit breakers. Circuit breakers alone may not provide adequate protection in certain high-power-tube circuits when the power-supply filter, modulator, or pulse-forming network stores considerable energy. Additional protection may be provided by the use of high-speed electronic circuits or electronic "crow-bars" to bypass the fault current until mechanical circuit breakers are opened.

Great care should be taken during the adjustment of circuits. The tube and its associated apparatus, especially all parts which may be at high potential above ground, should be housed in a protective enclosure. The protective housing should be designed with interlocks so that personnel cannot possibly come in contact with any high-potential point in the electrical system. The interlock devices should function to break the primary circuit of the high-voltage supplies and discharge high-voltage capacitors when any gate or door on the protective housing is opened, and should prevent the closing of this primary circuit until the door is again locked.

ELECTRICAL CONSIDERATIONS

Cathode—RCA transmitting tubes use a wide variety of cathodes. All utilize thermionic emission and should be operated at a constant temperature.

Refer to the *General Section* of the Handbook for a detailed discussion on TYPES OF CATHODES AND THEIR USE.

Filament or Heater—The rated filament or heater voltage should be applied for the heating time specified in the published data to allow the cathode to reach normal operating temperature before voltages are applied to other electrodes.

The life of the cathode can be conserved by adjusting to the lowest filament or heater supply voltage that will give the desired performance. In general, the filament or heater voltage values given in the published data include the maximum value and the typical value. Exceeding the maximum value will damage or severely shorten the life of the cathode.

The filament or heater voltage should be adjusted to the typical value initially, then reduced to provide satisfactory tube performance; any further reduction will show some degradation.

Good regulation of the filament or heater voltage about the value found above is, in general, economically advantageous from the view-point of tube life. When the rated value is shown with a percentage value in the published data, the percentage value indicates the tolerable momentary fluctuations from the rated value. For longer life, especially at higher operating frequencies, these fluctuations should be reduced by improved power supply regulation.

The cathode may be subjected to back bombardment as the frequency is increased with resultant increase in temperature. In pulse types back bombardment normally need not be considered when the duty factor is small. However, higher duty factors increase the possibility of this effect. In any event, the filament or heater supply voltage should be reduced as described above.

Standby Operation—During standby periods, the tube may be operated at decreased filament or heater voltage to conserve life. It is recommended that the filament or heater voltage be reduced to no less than 80 per cent of normal during standby periods of up to 2 hours. For longer periods, the filament or heater voltage should be turned off.

Filament Overvoltage Pulse Circuits—In certain battery-operated equipment, such as emergency-type, remote-area, or mobile applications, it is of utmost importance to conserve battery power. Quick-heating RCA power tubes provide useful power outputs within about one second from a cold start. This fast "warm-up" feature eliminates the need for standby filament power, resulting in significant conservation of battery power.

In general, "warm-ups" of about one second are adequate in equipment where the microphone switch actuating the transmitter power relay is located in the cradle of the handset, such as a conventional telephone, or similar wall-type installation. However, when the switch is the push-button type located on the handset, faster "warm-ups" are demanded. Extremely fast "warm-ups" of less than 200 milliseconds are possible for such "push-to-talk" microphone switches by the use of a suitably designed filament overvoltage pulse circuit or "hot-shot" circuit.

The diagram shown in Fig.3 depicts the filament-voltage waveform during a transmission using a "hot-shot" circuit. An overvoltage

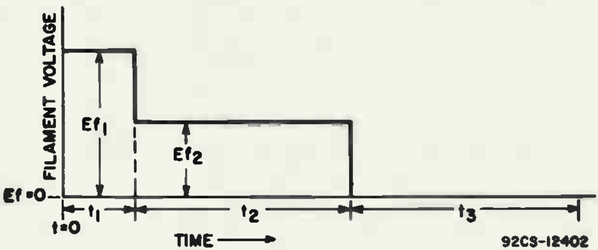

FIG.3 - FILAMENT VOLTAGE WAVE FORM

E_{f1} is applied for time t_1. A transfer switch then reduces the filament voltage to the rated value, E_{f2}, for the remainder of transmission time t_2. During standby time t_3, the filament voltage is zero.

The block diagram shown in Fig.4 depicts the basic requirements of a "hot-shot" circuit in conjunction with the communication equipment. The auxiliary circuit must provide a low-impedance filament overvoltage source, a rated filament voltage source, an accurately timed means of switching these sources, and a protective circuit to prevent possible damage to the tube filament from repeated applications of overvoltage with insufficient time for the filament to cool between transmissions. Both filament voltages are obtained from the transmitter power supply. Power is supplied simultaneously to the transmitter and timer

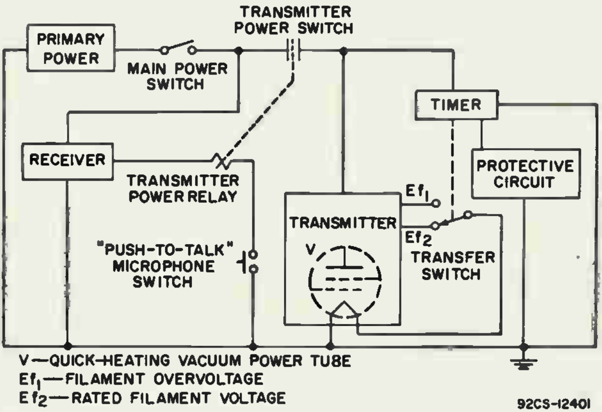

FIG.4 - BASIC RECEIVER-TRANSMITTER WITH AUXILIARY "HOT-SHOT" CIRCUIT

by the "push-to-talk" microphone switch. The transfer switch, which is initially connected to the filament overvoltage source, is switched by the timer to the rated filament voltage source in the required time (pulse duration) after application of power to the transmitter.

Before a "hot-shot" circuit can be designed for a quick-heating tube, it is necessary to establish maximum ratings for the peak voltage (on the order of 2 to 3 times the rated filament voltage) and duration of the filament overvoltage pulse for the desired heating time. Filament overvoltage pulse ratings are given in the published data on quick-heating tube types.

Any "hot-shot" circuit design must provide protection against the application of the filament overvoltage pulse to a hot filament.

It is recommended that a dummy filament, simulating the resistance of the specific tube type, be used in the initial testing or checking of a "hot-shot" circuit design. Otherwise, any fault—especially an excessive pulse duration can cause catastrophic failure of the tube.

Plate Voltage Supply—Power-amplifier tubes usually obtain plate voltage from rectifiers provided with suitable filter circuits, although batteries or local dc generators are sometimes used, especially in portable and mobile equipment.

A time-delay relay should be provided in the plate-supply circuit to delay application of plate voltage until the filament or heater has reached normal operating temperature.

An interlocking relay system should be provided to prevent application of plate voltage prior to the application of sufficient bias voltage and/or rf drive to grid No. 1; otherwise, with insufficient bias, the resultant high plate current may cause excessive plate dissipation with consequent damage to the tube. RF-load shorts or other causes of high output VSWR may also cause high dissipations, excessive voltage gradients, or insulator flashovers. The VSWR should be monitored and the detected signal used to actuate the interlock system to remove the plate voltage in less than 10 milliseconds after the fault occurs.

In beam power tubes with closely spaced electrodes, extremely high-voltage gradients occur even with moderate tube operating voltages. Consequently, momentary fault currents may cause catastrophic failure unless protection is provided. A series impedance in the plate lead is recommended. A resultant plate impedance, which will provide a plate-voltage-supply regulation of no better than 10 per cent, is usually sufficient.

Grid-No.2 Voltage Supply—The grid No.2 must be protected by a time-delay and interlocking relay similar to the plate-voltage-supply protection described for Plate Voltage Supply. The plate voltage should be applied simultaneously with or before the grid-No.2 voltage; otherwise, with voltage on grid No.2 only, grid-No.2 current may be large enough to cause excessive grid-No.2 dissipation. If the grid-No.2 voltage is obtained from the plate voltage supply, these precautions will have been accomplished.

Grid-No.2 current is composed of a positive-current component resulting from cathode emission to grid No.2 and a negative-current component resulting from secondary-emission phenomena. Because the net result of these component currents is read on a meter in the grid-No.2 circuit, grid-No.2 dissipation can not be accurately determined. Operation similar to conditions given under *Typical Operation* in the published data will minimize the possibility of exceeding maximum dissipation.

In tubes with precision-aligned grids, such as Cermolox tubes, the grid-No.2 circuit must be capable of maintaining the proper grid-No.2 voltage in the presence of moderate negative dc current as well as normal values of positive current. Complete protection can be achieved by the use of a well-regulated power supply, a grid-No.2-to-ground impedance that is low enough to prevent gradual build-up of grid-No.2 voltage and/or catastrophic build-up (runaway) under negative-current conditions, and a current-overload relay to protect the grid No.2 against positive or negative currents on the order of one-tenth the required plate current.

Grid-No. 1 Voltage Supply—The grid-No.1 bias circuit should preferably be adjustable to permit small variations of grid-No.1 voltage. This bias adjustment will permit setting the desired plate current, and it will minimize variations in tube performance. Sufficient fixed bias or cathode resistor bias should be provided to protect the tube in the event that the drive signal is lost.

The design of the bias-voltage supply should include an instantaneous over-current relay. The action of the over-current relay and the inherent regulation of the supply should be such that no damage to the tube or supply will result from an accidental short at the tube connection or from an internal tube fault.

The rf-power-input transmission line should be provided with VSWR protection to remove drive power as well as plate (and grid No.2) voltage within 10 milliseconds in the event of abnormal changes in input VSWR during operation.

CLASSES OF SERVICE

AF Power Amplifiers—The current and power values in the Maximum Ratings are averaged over any audio-frequency cycle of sine-wave form. The driver stage should be capable of supplying at low distortion the No.1 grid(s) with the value of peak af voltage given in the *Typical Operation* of the published data. In no case should the Grid-No.1-Circuit Resistance exceed the value specified under *Maximum Circuit Values*. Transformer or impedance coupling devices are recommended.

Individual bias adjustment for each tube (unit) should be used to balance the loading and minimize distortion. In push-pull operation the bias of each tube (unit) should be adjusted to divide the value of zero-signal plate current in the published data equally between the two tubes (units).

Except for class A amplifiers, the average plate and grid No.2 currents vary with the amplitude of the driving signal. Hence, serious distortion and inadequate power output will result with large input signals unless the plate and grid-No.2 power supplies are well regulated.

Class A—This class normally does not draw grid-No.1 current or requires tube driving power and can employ simple cathode bias. Where class A_2 (indicating grid-No.1 current flows during part of the cycle) is specified, the grid-No.1 circuit precautions discussed under class AB_2 operation will apply.

Class AB_1—The subscript 1 in class AB_1 indicates that grid-No.1 current **does** not flow during any part of the cycle.

Class B and Class AB_2—These classes normally draw grid-No.1 current (indicated by the subscript 2 in AB_2) with large signals and, therefore, require tube driving power. To minimize distortion, the grid-No.1 bias supply preferably should be regulated or held to a low value of effective resistance. Transformer coupling should be used.

RF Power Amplifiers or Oscillators—On modern ceramic-metal envelope types, the frequency selected is usually the maximum value at which reasonable gain and efficiency are obtained. In glass-envelope types, the maximum frequency is selected as the frequency above which excessive rf envelope losses require voltage deratings and reduced efficiency requires input deratings.

Driving power values given in the published data include only the power that must be delivered to the tube and bias supply. The term, "driving power", is normally used only at low frequencies where circuit losses are small.

Where *Driver-Power Output* is shown in the published data, the rf losses associated with a typical input circuit are also included.

In cathode-drive circuits, a portion of the driver-power output and the developed rf power output act in series to supply the load circuit. If the driving power is increased, the output will always increase. In a grid-drive circuit, a saturation effect takes place; i.e., above a certain value of driving voltage and current, the output increases very slowly and may even decrease. It is important to recognize this difference and not try to saturate a cathode-drive stage; otherwise, the maximum grid-No.1 and grid-No.2 input may easily be exceeded.

Parasitic oscillations may be experienced under certain operating conditions. Such oscillations result in erratic performance and may cause damage to the tube and/or associated circuitry. Operating conditions and external circuits should be adjusted for operation without oscillations. References 10 and 11 are suggested for further information on the detection and suppression of parasitic oscillations.

Class C Plate-Modulated-Power Amplifiers— In plate-modulated class C amplifier service, the tube can be modulated 100 per cent. The grid-No.2 voltage must be modulated simultaneously with the plate voltage so that the ratio of grid-No.2 voltage to plate voltage remains constant.

Grid-No.2 voltage should be obtained preferably from a separate source modulated from a separate winding on the modulation transformer.

Bias voltage may be obtained from a grid-No.1 resistor, but preferably is obtained from a combination of grid-No.1 resistor with either fixed supply or cathode resistor to protect the tube in the event the drive signal is lost.

In cathode-drive, plate-modulated, class C rf power amplifier service, the tube can be modulated 100 per cent if the rf driver stage is simultaneously modulated 100 per cent. Care should be taken to insure that the driver-modulation and amplifier-modulation voltages are exactly in phase.

Class C CW Power Amplifiers—In class C rf telegraphy service, the tube may generally be supplied with bias by any convenient method: from fixed supply, by grid-No.1 resistor, by cathode resistor, or by combination methods. However, when the tube is used in the final amplifier or a preceding stage of a transmitter designed for break-in operation and oscillator keying, an amount of fixed bias must be used to limit the plate current and, therefore, the plate dissipation to a safe value. Some fixed bias is preferred in any event to protect the tube in case the drive signal is lost.

Grid-No.2 voltage should be obtained preferably from a separate source. It can also be obtained from the plate-supply voltage with a voltage divider, or through a series resistor. A series grid-No.2 resistor should be used only when the tube is used in a circuit which is not keyed.

Linear RF Power Amplifiers—The classes of operation suitable for linear rf power amplifiers include: class A, class AB_1, class AB_2, class B with bias, and class B with zero bias. Class A operation is the more nearly linear, but it is also the least efficient. Application is generally limited to low-power-level amplification. Class AB_1 produces the best compromise for linearity, efficiency, and gain. Class AB_2 or class B operation provides higher output for applications where sufficient driving power is available to permit some "swamping", and where linearity requirements are less stringent. Class B zero-bias operation with suitable high mu triodes may be used when adequate driving power is available.

In general, grid-No.2 voltage should be obtained from a separate, well-regulated source. In circuits where the grid-No.1 current is drawn, a separate, well-regulated source is also required.

(1) - **Single-Sideband, Suppressed Carrier Service**—Single sideband suppressed carrier operation is a form of linear amplifier service in which only one sideband is transmitted, and the carrier is suppressed.

The values of *Distortion Products Level* given under *Typical Operation* in the published data are referenced to either of the two tones for "two-tone" modulation and are without the use of feedback to enhance linearity.

(2) - **Class B and Class C Television Service**—Television is a form of linear amplifier service in which the rf carrier is modulated by a video signal. Typical operation is given at conditions of a specified bandwidth measured between the half-power points.

The values for the pertinent parameters given under *Typical Operation* in the published data are given at the synchronizing (sync) level and pedestal level (black level or blanking level).

(3) - **Class B Telephony Service**—Class B telephony service is a form of linear amplifier service in which the grid is excited with an rf carrier that is modulated at audio frequencies in one of the preceding stages. Under these conditions, plate dissipation is greatest when the carrier is unmodulated. Grid bias should be obtained from a dc voltage source of good regulation.

Pulsed RF Amplifiers and Oscillators—This service consists of the generation and amplification of an rf signal, the envelope of which is a waveform limited to intermittent pulses of defined shape, duration, and repetition frequency. Pulse duration and duty factor are sometimes limited directly by the maximum ratings. More frequently, the maximum ratings define a relationship between these factors as a maximum "ON" time in a given time interval in order to cover pulse-train inputs. Typical operation, in general, is given for conditions with a rectangular waveshape pulse of a given duration and duty factor. For operation at pulse durations or duty factors other than those given in the published data, see Ref.12.

In the amplifier service, the power supply pulses should preferably start shortly after and end shortly before the rf drive pulse to reduce the possibility of parasitic oscillations. If the rf drive pulses are "gated" within the power-supply pulses (the rf drive pulse starts shortly after and ends shortly before the power-supply pulses), the desired "gate" conditions should be observed carefully when no rf drive pulse is present to be assured that no oscillations are present.

The peak input energy required during the pulse is normally obtained from capacitor banks that must store many times this peak value to prevent excessive voltage droop. Consequently, it is particularly important to observe all the precautions for limiting tube input during faults which are described under Grid-No.2 Voltage Supply.

Pulse-Modulated RF Amplifiers—This service consists of the simultaneous amplification and pulse modulation of a cw rf signal. If differs from the other more conventional modulated rf amplifier services in that the modulating waveform is limited to intermittent pulses of defined shape, duration, and repetition frequency. This type of amplification/modulation is normally done at low power levels; hence, few power tubes are rated specifically for this service.

Pulse Modulator Service—The tube supplies a modulation signal consisting of intermittent pulses of defined shape, duration, and repetition frequency. Ratings, waveforms, and precautions are similar to those given for pulsed rf amplifier service (except there is no rf drive signal).

Observation of the exact waveforms must be made with an oscilloscope. In this manner, transient voltage or current spikes caused by unavoidable circuit reactances may be observed. Transient values must be held within the maximum ratings given in the published data.

High-power pulse modulators, when used to "clip" or "flat-top" the output waveform by the overdriving technique, must provide grid-No.1 and grid-No.2 input protection.

Plate current flow during the "OFF" time will contribute to plate dissipation; the bias voltage should be sufficient to hold the plate current below the required levels for any tube. The control limits, such as found in the Characteristics Range Values will provide information in determining the required bias. Current flow during the rise time and the fall time of a "rectangular" pulse can contribute significantly to plate dissipation; this current flow should be considered if the theoretical plate dissipation is close to the rated value.

Voltage Regulator Service—The tube acts as a "pass tube" having a controllable voltage drop in a series-regulated voltage-supply circuit. The plate voltage rating can be interpreted as applying to the actual plate-to-cathode voltage of the tube rather than the supply voltage. In this case, adequate protective devices must be used to protect the tube in the event of a shorted load. Special precaution should be made to observe the maximum circuit values for grid-No.1 and grid-No.2 impedance. For information on voltage regulator circuits, see Refs. 13, 14, and 15.

It is recommended that only tube types rated for this service be used since the use of a high power vacuum tube in a high-voltage, low-current application will frequently result in the selection of a tube inadequately controlled in the low-current region.

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[a] Made by the Tempil Corp., 132 W. 22nd Street, New York 1, New York.

[b] Manufactured by the Fluorchemical Division, Minnesota Mining and Manufacturing Co., 900 Bush Avenue, St.Paul 6, Minnesota.

[c] Warning: Beryllia dust and fumes are highly toxic to mucous membranes and may cause serious ulcers when imbedded under the skin. See References 7, 8, and 9.

REFERENCES

Copies for references 1, 3, 4, and 6 may be obtained by writing to Commercial Engineering, Radio Corporation of America, Harrison, New Jersey.

1. *Techniques for Measuring Electron-Tube Bulb Temperatures, RCA Application Note, AN-200*.

2. *Design Manual of Natural Methods of Cooling Electronic Equipment*, Department of the Navy, Bureau of Ships, Navships 900, 192.

3. *Blower Requirements for RCA Forced-Air-Cooled Tubes*, RCA Application Note, AN-161.

4. *Application Guide for RCA Super-Power Tubes*, 1CE-279A.

5. *Design Manual of Methods of Liquid Cooling Electronic Equipment*, Department of the Navy, Bureau of Ships, Navships 900, 195.

6. J. W. Gaylord, *"The Conduction Cooling of Power Tubes in Vehicular Communication Equipment,"* IEEE Transactions on Vehicular Communications, September, 1963.

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7. D. W. White, Jr. and J. E. Burke, *"The Metal Beryllium"* (book), published by the American Society for Metals, Cleveland, Ohio.

8. Donald P. O'Neil, *"Toxic Materials Machined Safely,"* American Machinist, June 4. 1955.

9. Sidney Laskin, Robert A. N. Turner, and Herbert E. Stokinger, *"Analysis of Dust and Fume Hazards in a Beryllium Plant,"* U.S. Atomic Energy Commission, MDDC-1355.

10. F. E. Terman, *"Radio Engineers' Handbook,"* pages 498 to 503 of 1943 edition. Published by McGraw-Hill Pub. Co., Inc.

11. EE Staff of MIT, *"Applied Electronics,"* page 619.

12. *Predicted Cathode Capability,* RCA Power Tube Engineering Note, IEN-1.

13. F. V. Hunt, & R. W. Hickman, Review of Scientific Instruments, *"On Electronic Voltage Stabilizers,"* January, 1939.

14. F. E. Terman, *"Radio Engineers' Handbook,"* pages 614 and 615 of 1943 edition. Published by McGraw-Hill Pub. Co., Inc.

15. Cruft Electronics Staff, *"Electronic Circuits and Tubes,"* page 575. Published by McGraw-Hill Pub. Co., Inc.

Transmitting Tube Ratings vs Operating Frequency

The MAXIMUM RATINGS given for each type on its data pages apply only when the type is operated at frequencies lower than some specified value which depends on the design of the type. As the frequency is raised above the specified value, the radio-frequency currents, dielectric losses, and heating effects increase rapidly. Most types can be operated above their specified maximum frequency provided the plate voltage and plate input are reduced in accordance with the information given in the following tabulation.

TUBE TYPE	OPERATING FREQUENCY Mc	MAXIMUM PERMISSIBLE PERCENTAGE OF MAXIMUM RATED PLATE VOLTAGE & PLATE INPUT		
		TELEPHONY		TELEGRAPHY
		Class B, Class C Grid or Suppressor Modulated	Class C Plate-Modulated	Class C Unmodulated
8D21	300	100	–	100
207	Same as for Type 892			
211	15 30 80	100 88 70	100 80 50	100 80 50
801-A	60 75 120	100 93 78	100 80 50	100 80 50
803	20 40 60	100 86 80	100 77 60	100 77 60
805	30 45 80	100 90 77	100 82 55	100 82 55
807	60 80 125	100 90 75	100 80 55	100 80 55
809	60 70 120	100 93 75	100 88 50	100 88 50
810	30 60 100	100 88 80	100 70 50	100 70 50
813[a]	30 60 120	100 88 76	100 75 50	100 75 50

[a] In Self-Rectifying Oscillator or Amplifier Service, and in Amplifier or Oscillator Service with Separate, Rectified, Unfiltered, Single-Phase, Full-Wave Plate Supply, the 813 has the same maximum permissible percentages as those shown for Class C Telegraphy.

Transmitting Tube Ratings vs Operating Frequency

TUBE TYPE	OPERATING FREQUENCY Mc	MAXIMUM PERMISSIBLE PERCENTAGE OF MAXIMUM RATED PLATE VOLTAGE & PLATE INPUT		
		TELEPHONY		TELEGRAPHY
		Class B, Class C Grid or Suppressor Modulated	Class C Plate-Modulated	Class C Unmodulated
814	30 50 75	100 90 85	100 80 64	100 80 64
815	125 175 200	100 85 75	100 80 70	100 80 70
828	30 50 75	100 90 80	100 80 65	100 80 65
830-B	15 30 60	100 87 74	100 77 54	100 77 54
832-A	200 250	– –	100 89	100 89
834	100 170 350	100 89 73	100 80 53	100 80 53
835	20 40 100	100 85 70	100 80 50	100 80 50
837	20 40 60	– – –	100 76 62	100 76 62
838	30 60 120	100 85 70	100 75 50	100 75 50
860	Same as for Type 838			
880	 25 50 75 100	*Voltage* *Input* 100 100 80 94 68 85 60 75	 100 72 56 45	 100 75 62 50
889-A	50 100 150	100 85 72	100 75 50	100 75 50
889R-A	 40 65 100	 100 85 72	 100 78 60	*Volt.* *Input* 100 100 87 73 65 50

Transmitting Tube Ratings vs Operating Frequency

TUBE TYPE	OPERATING FREQUENCY Mc	MAXIMUM PERMISSIBLE PERCENTAGE OF MAXIMUM RATED PLATE VOLTAGE & PLATE INPUT — TELEPHONY: Class B, Class C Grid or Suppressor Modulated	TELEPHONY: Class C Plate-Modulated	TELEGRAPHY: Class C Unmodulated
891	1.6 7.5 20	– – –	– – –	100 75 50
891-R	1.6 7.5 20	– – –	– – –	100 75 50
892	1.6 7.5 20	100 85 76	100 85 75	100 75 50
892-R	1.6 7.5 20	100 85 76	100 75 50	100 75 50
1613	45 60 90	– – –	100 90 85	100 90 85
1614	80 120	– –	100 75	100 75
1619	45 60 90	100 93 85	100 90 77	100 90 77
1624	60 80 125	100 90 75	100 80 55	100 80 55
1625	Same as for Type 807			
1626	30 60 90	– – –	– – –	100 96 93
5713	220	–	–	100
5763	 50 175	 – –	*Volt.* *Input* 100 100 100 80	*Volt.* *Input* 100 100 100 80
5771	 1.6 25 50	 100 100 75	 100 100 75	*Volt.* *Input* 120 112.5 100 75
5786	160	–	100	100
6417	Same as for Type 5763			
8005	60 80 100	100 90 83	100 75 60	100 75 60

RCA

CIRCUITS FOR HOT-CATHODE MERCURY-VAPOR & GAS RECTIFIER TUBES

Numerical Relationships Among Electrical Quantities

E = Trans. Sec. Voltage (RMS)
E_{av} = Average DC Output Voltage
E_{bmi} = Peak Inverse Anode Voltage
E_m = Peak DC Output Voltage
E_r = Major Ripple Voltage (RMS)
f = Supply Frequency
f_r = Major Ripple Frequency
I_{av} = Average DC Output Current
I_b = Average Anode Current
I_p = Anode Current (RMS)
I_{pm} = Peak Anode Current
P_{al} = Line Volt-Amperes
P_{ap} = Trans. Pri. Volt-Amperes
P_{as} = Trans. Sec. Volt-Amperes
P_{dc} = DC Power ($E_{av} \times I_{av}$)

Note: Conditions assumed involve sine-wave supply; zero voltage drop in tubes; no losses in transformer and circuit; no back emf in the load circuit; and no phase-back.

RATIO	Fig. 1	Fig. 2	Fig. 3	Fig. 4	Fig. 5*	Fig. 6	Fig. 7	Fig. 8
Voltage Ratios								
E/E_{av}	2.22	1.11	1.11	0.854	0.854	0.427	0.785	0.74
E_{bmi}/E	1.41	2.83	1.41	2.45	2.45	2.45	2.83	2.83
E_{bmi}/E_{av}	3.14	3.14	1.57	2.09	2.09	1.05	2.22	2.09
E_m/E_{av}	3.14	1.57	1.57	1.21	1.05	1.05	1.11	1.05
E_r/E_{av}	1.11	0.472	0.472	0.177	0.04	0.04	0.106	0.04
Frequency Ratio								
f_r/f	1	2	2	3	6	6	4	6
Current Ratios								
I_p/I_{av}	1.57	0.785	0.785	0.578	0.289	0.578	0.5	0.408
I_b/I_{av}	1	0.5	0.5	0.33	0.167	0.33	0.25	0.167
Resistive Load								
I_{pm}/I_{av}	3.14	1.57	1.57	1.21	0.52	1.05	1.11	1.05
I_{pm}/I_b	3.14	3.14	3.14	3.63	3.14	3.14	4.5	6.3
Inductive Load°								
I_{pm}/I_{av}	—	1	1	1	0.5	1	1	1
Power Ratios								
Resistive Load								
P_{as}/P_{dc}	3.49	1.74	1.24	—	—	—	—	—
P_{ap}/P_{dc}	2.69	1.23	1.24	—	—	—	—	—
P_{al}/P_{dc}	2.69	1.23	1.24	—	—	—	—	—
Inductive Load°								
P_{as}/P_{dc}	—	1.57	1.11	1.71	1.48	1.05	1.57	1.81
P_{ap}/P_{dc}	—	1.11	1.11	1.21	1.05	1.05	1.11	1.29
P_{al}/P_{dc}	—	1.11	1.11	1.21	1.05	1.05	1.11	1.05

* Bleeder current of 2% full-load current will provide exciting current for balance coil and thus avoid poor regulation at light loading.
° The use of a large filter-input choke is assumed.

CIRCUITS FOR HOT-CATHODE MERCURY-VAPOR & GAS RECTIFIER TUBES

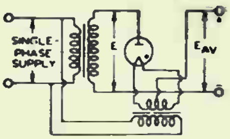


FIG. 1 HALF-WAVE SINGLE-PHASE

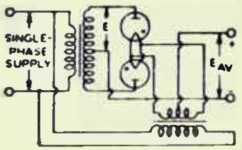


FIG 2 FULL-WAVE SINGLE-PHASE

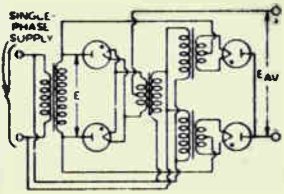


FIG. 3 SERIES SINGLE-PHASE

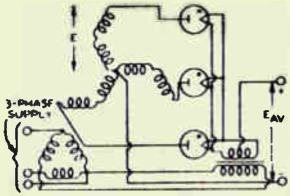


FIG 4 HALF-WAVE THREE-PHASE

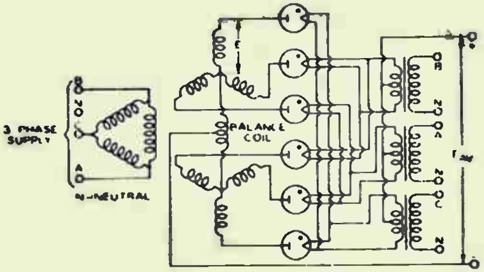


FIG 5 PARALLEL THREE-PHASE (QUADRATURE OPERATION)

92CL-7873A

RCA

CIRCUITS FOR HOT-CATHODE MERCURY-VAPOR & GAS RECTIFIER TUBES

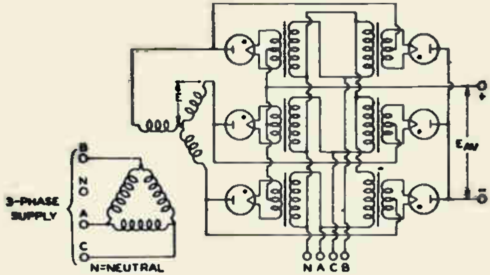


FIG. 6 SERIES THREE-PHASE (QUADRATURE OPERATION)

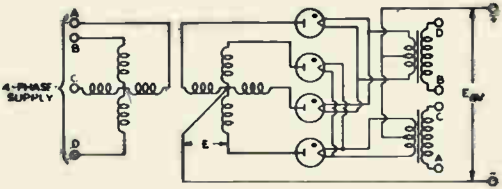


FIG. 7 HALF-WAVE FOUR-PHASE (QUADRATURE OPERATION)

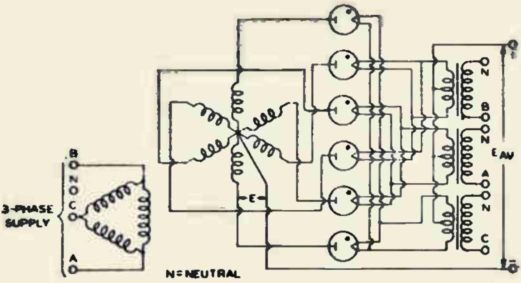


FIG. 8 HALF-WAVE SIX-PHASE (QUADRATURE OPERATION)

92CL-7873B

2K26
KLYSTRON

SINGLE-RESONATOR, REFLEX TYPE

Frequency: 6250 to 7060 Mc.

GENERAL DATA

Electrical:

Heater, for Unipotential Cathode:

Voltage	6.3 ± 0.5	ac or dc volts
Current	0.44	amp
Frequency Range	6250 to 7060	Mc

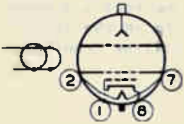
Mechanical:

Mounting Position	Any
Dimensions, Terminal Connections, and Mechanical Tuning Mechanism	See Outline Drawing
Resonant Cavity	Integral Part of Tube
Envelope	Metal
Cap	Miniature with Wafer
Base	Small-Wafer Octal 4-Pin with Pin No.4 replaced by Coaxial Output Line

BOTTOM VIEW

Pin 1 - Shell, Resonator

Pin 2 - Heater



Pin 7 - Heater

Pin 8 - Cathode

Cap - Reflector Terminal

NOTE: COAXIAL OUTPUT LINE PASSES THROUGH VACANT PIN POSITION No. 4

CW OSCILLATOR - Class C

Maximum Ratings, *Absolute Values*:

DC RESONATOR VOLTAGE	330 max.	volts
DC REFLECTOR VOLTAGE:		
Positive Value	0 max.	volts
Negative Value	350 max.	volts
DC RESONATOR CURRENT	35 max.	ma
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	50 max.	volts
Heater positive with respect to cathode	50 max.	volts
AMBIENT TEMPERATURE OF SHELL	110 max.	°C
TEMPERATURE OF COAXIAL OUTPUT LINE	90 max.	°C

Typical Operation □ at 6660 Mc in Mode "A" with 3/4" x 1-1/2" Wave Guide

DC Resonator Voltage	300	volts
DC Reflector Voltage Range ▲	-65 to -120	volts
DC Resonator Current	25	ma
DC Reflector Current	less than 7	µa

(continued on next page)

□, ▲: See next page.

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2K26

2K26
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Half-Power Electronic-Tuning Frequency Change■	55	Mc
Power Output	120	mw

▲ Adjusted for maximum power output at the given operating frequency.

■ Change in frequency between the two half-power points when the reflector voltage is varied above and below the point of maximum power output corresponding to the given frequency.

□ The coaxial output line is coupled to the specified wave guide through the wide-band coaxial coupling unit shown on following pages.

INSTALLATION NOTES

A socket for the 2K26 may be obtained by removing the clip from the No.4 pin position of an octal socket and drilling the No.4 opening large enough to admit the coaxial line and the surrounding coupling unit. To guard against excessive strain on the coaxial output line, the tube must be securely fastened by a clamp on the base of the socket mounting. Bumping or continued pressure on the output line will seriously damage the tube. The proper area for clamping on the shoulder of the header skirt is shown on the Outline Drawing.

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2K26
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OPERATING NOTES

All tabulated data and curve information shown for the 2K26 were taken with the specified coupling unit and wave guide. It is important that this coupling unit or its electrical equivalent be used to insure tube interchangeability and satisfactory tuning characteristics. In addition, the standing-wave ratio of the coupler should not exceed 0.8 db. (1.1 voltage-standing-wave ratio).

In most applications the cathode of the 2K26 is operated at a negative potential with respect to ground so that the tube shell, which is integral with the resonator, is at ground potential. In those applications which do not operate with the shell at ground potential, it is essential that the 2K26 be surrounded by a grounded shield and tuned with an insulated tool, in order to protect the user from contact with high voltage. The shield design should permit adequate ventilation to assure that ambient temperature, as measured with a thermometer inserted between the metal tube shell and the shield, will be less than the maximum rated value. Ambient temperature changes will cause the resonator to expand or contract, producing a change in frequency. For best frequency stability, the 2K26 should be operated at nearly constant ambient temperature and with a well-regulated power supply.

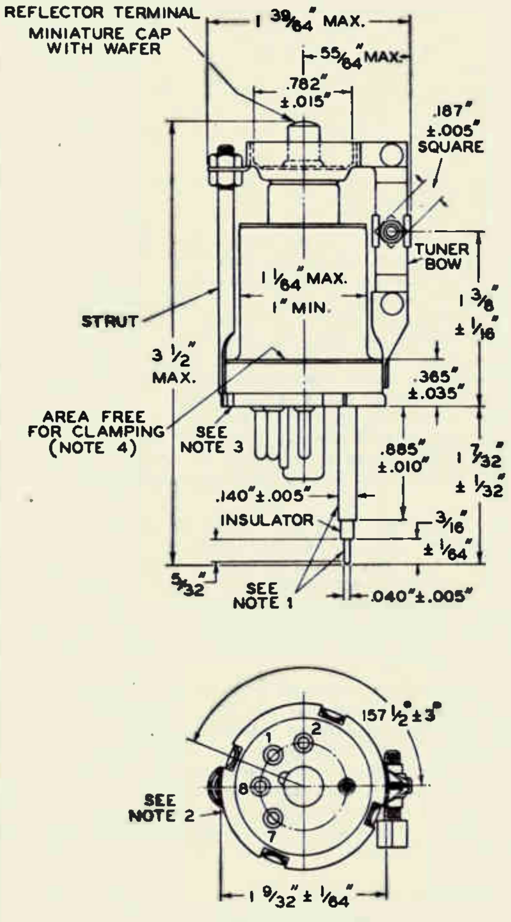
Shielding of the reflector and resonator voltage leads as close to the tube as possible is essential to avoid modulation of the tube output by any external voltages. In addition, the connection to the reflector terminal must be insulated to withstand the total acceleration and reflector voltage. To avoid damage to the tube, the reflector potential must never become positive with respect to the cathode.

Tuning of the 2K26 is accomplished by mechanical and electronic means. The mechanical tuning system is designed to permit approximate adjustment of frequency, but is not recommended for use where continual or frequent adjustment of frequency is required. Approximately five full turns of the frequency-adjustment screw are sufficient to tune the tube over its rated frequency range. The electronic tuning range is dependent upon reflector voltage, the type of load and the kind of coupling to the load.

Voltage modes are regions within the total range of reflector voltage in which oscillations will occur. The typical operating conditions and curves shown for type 2K26 apply to mode "A", the only mode recommended for this tube.

2K26

2K26
KLYSTRON



BOTTOM VIEW

NOV. 15, 1948

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2K26

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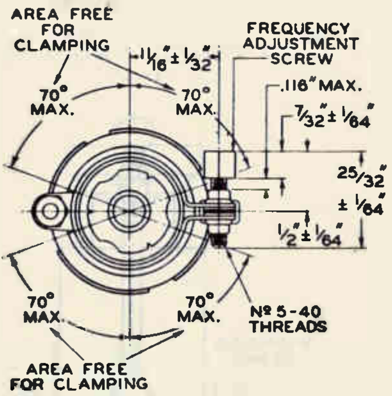

TOP VIEW

NOTE 1: THE INNER AND OUTER CONDUCTORS OF THE COAXIAL OUTPUT LINE ARE CONCENTRIC WITHIN 0.010".

NOTE 2: BASE-PIN AND COAXIAL-OUTPUT-LINE POSITIONS ARE HELD TO TOLERANCES SUCH THAT PINS AND OUTPUT LINE WILL FIT FLAT-PLATE GAUGE HAVING (a) THICKNESS OF 1-7/32", (b) 4 HOLES WITH DIAMETER OF 0.1030" ± 0.0005" FROM TOP SURFACE OF GAUGE TO A DEPTH OF 0.25" AND THEN WITH DIAMETER INCREASED BY APPROXIMATELY 1/64" FOR REMAINING DEPTH OF HOLE, SO LOCATED ON A 0.6870" ± 0.0005" DIAMETER CIRCLE THAT THE DISTANCE ALONG THE CHORD BETWEEN ANY TWO ADJACENT HOLE CENTERS IS 0.2630" ± 0.0005", (c) ONE HOLE WITH DIAMETER OF 0.1600" ± 0.0005" TO DEPTH OF 1-7/32" WHOSE CENTER IS LOCATED ON THE SPECIFIED PIN CIRCLE A DISTANCE DETERMINED BY LAYING OFF ON THE TOP SURFACE OF THE GAUGE COUNTERCLOCKWISE FROM THE LAST OF THE FOUR HOLES TWO CONSECUTIVE CHORDS EACH 0.2630" ± 0.0005", AND (d) A CENTER HOLE WITH A MINIMUM DIAMETER OF 0.400" TO CLEAR THE BASE PLUG AND KEY. PIN AND OUTPUT-LINE FIT IN GAUGE SHALL BE SUCH THAT GAUGE TOGETHER WITH SUPPLEMENTARY WEIGHT TOTALING 2 LBS. WILL NOT BE LIFTED WHEN PINS AND COAXIAL OUTPUT LINE ARE WITHDRAWN.

NOTE 3: SMALL-WAFER OCTAL 4-PIN BASE WITH PIN No.4 REPLACED BY COAXIAL OUTPUT LINE.

NOTE 4: MINIMUM WIDTH OF SHOULDER IS 0.045".

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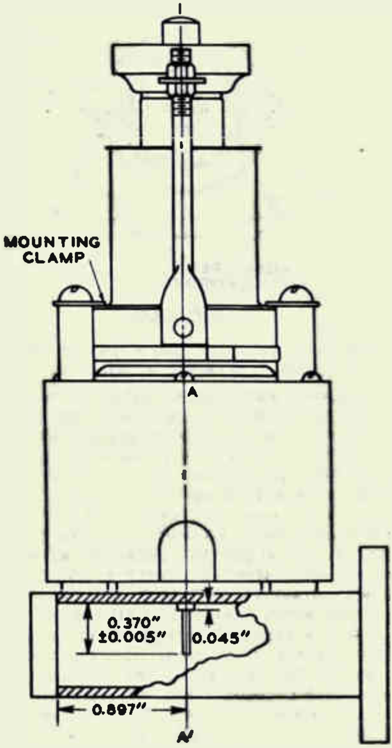
COUPLING ARRANGEMENT

RCA-2K26 Coupled to a 3/4" x 1-1/2" Wave Guide Through a Coaxial Transducer Coupling Circuit



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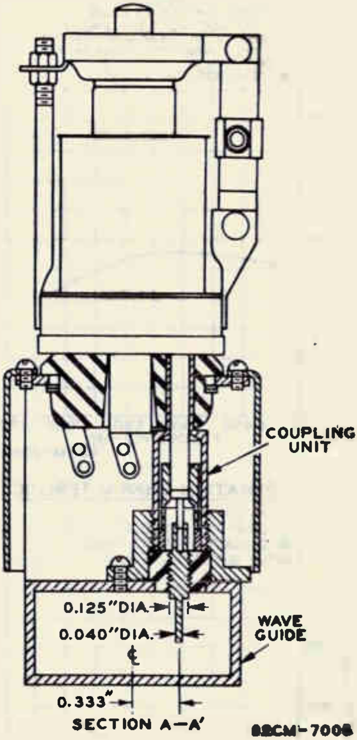
COUPLING ARRANGEMENT (Cont'd)



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2K26
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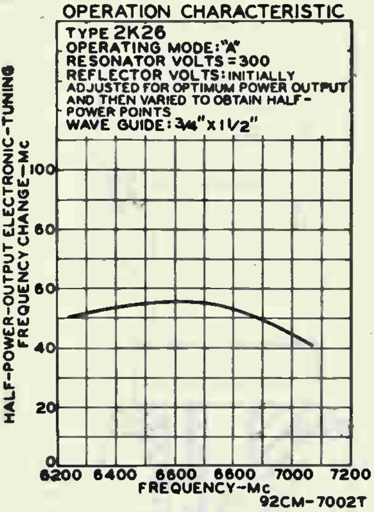

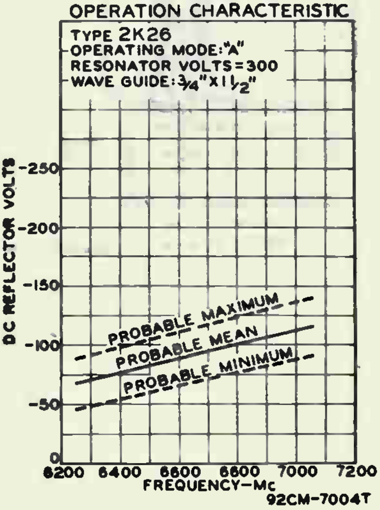

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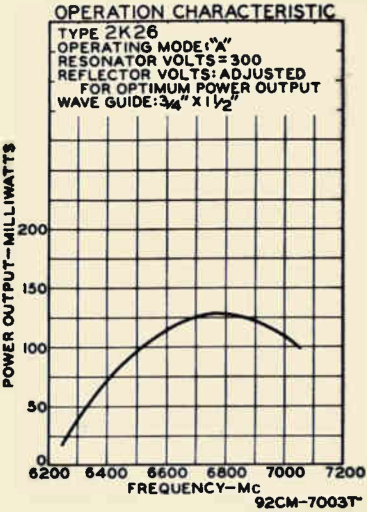
2K26
KLYSTRON



RCA

2X2-A

HALF-WAVE VACUUM RECTIFIER

For applications critical as to severe shock and vibration

GENERAL DATA

Electrical:

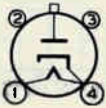
Heater, for Unipotential Cathode:

	Min.	*Av.*	*Max.*	
Voltage	2.25	2.50	2.75	ac volts
Current at 2.50 volts	1.55	1.75	1.95	amp

Mechanical:

Mounting Position	Any
Maximum Overall Length	4-17/32"
Seated Length	3-25/32" ± 1/8"
Maximum Diameter	1-9/16"
Dimensional Outline	*See General Section*
Weight (Approx.)	1.3 oz
Bulb	ST-12
Cap	Small (JETEC No.C1-1)
Base	Small-Shell Small 4-Pin (JETEC No.A4-5)
Basing Designation for BOTTOM VIEW	4AB

Pin 1 - Heater
Pin 2 - No Connection
Pin 3 - No Connection



Pin 4 - Heater, Cathode
Cap - Plate

HALF-WAVE RECTIFIER

Maximum Ratings, ***Design-Center Values:***

PEAK INVERSE PLATE VOLTAGE	12500 max.	volts
PEAK PLATE CURRENT	60 max.	ma
DC OUTPUT CURRENT	7.5 max.	ma
HOT-SWITCHING TRANSIENT CURRENT, for duration of 0.2 second max.	100 max.	ma
AMBIENT TEMPERATURE	70 max.	°C

Typical Operation:

AC Plate-Supply Voltage (RMS)	5500	volts
Total Effective Plate-Supply Impedance	0.3	megohm
Filter Input Capacitor	0.1	μf
DC Output Current	2	ma
DC Output Voltage (At input to filter)	4500	volts

SHOCK TEST DATA

Impact Acceleration	250 max.	g

This test is performed on a sample lot of tubes from each production run to determine ability of tube to withstand the specified impact acceleration. The tubes are subjected to a total of 3 blows in each of the 3 primary mutually

← indicates a change.

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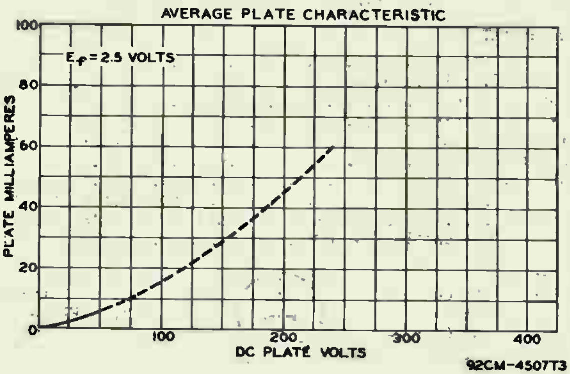
2X2-A

HALF-WAVE VACUUM RECTIFIER

perpendicular tube planes when tested in the Navy Type, High-Impact (flyweight) Shock Machine. At the end of this test, tubes will not show permanent or temporary shorts or open circuits, and will not be inoperative.



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3B28

HALF-WAVE GAS RECTIFIER

HOT-CATHODE TYPE

GENERAL DATA

Electrical:

Filament, Coated:

Voltage	2.5 ± 5%	ac volts
Current at 2.5 volts. .	5	amp
Minimum Heating Time Before Anode Voltage is Applied	10	seconds
Peak Anode Voltage Drop (Approx.)	10	volts

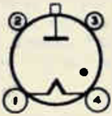
Mechanical:

Mounting Position	Any
Overall Length.	5.87" to 6.15"
Seated Length	5.25" to 5.53"
Maximum Diameter.	2-1/16"
Bulb.	T-16
Cap	Medium (JETEC No.C1-5)
Base. . .	Medium-Shell Small 4-Pin, Bayonet (JETEC No.A4-10)
Basing Designation for BOTTOM VIEW.	$4P_1$

Pin 1 – Filament

Pin 2 – No Connection

Pin 3 – No Connection



Pin 4 – Filament, Cathode Shield

Cap – Anode

HALF-WAVE RECTIFIER

Maximum Ratings, *Absolute Values*:

	Rating I	*Rating II*	
PEAK INVERSE ANODE VOLTAGE. .	5000 max.	10000 max.	volts
ANODE CURRENT:			
Peak.	2 max.	1 max.	amp
Average*.	0.5 max.	0.25 max.	amp
Fault, for duration of 0.1 second max.. . .	20 max.	20 max.	amp
FREQUENCY OF POWER SUPPLY . .	500 max.	150 max.	cps
AMBIENT TEMPERATURE	-75 to +90	-75 to +90	°C

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

	Note	*Min.*	*Max.*	
Filament Current.	1	-	5.40	amp
Critical Anode Voltage.	2	-	50	volts
Peak Anode Voltage Drop	3	-	14	volts

Note 1: With 2.5 volts rms on filament.

Note 2: With 2.38 volts rms on filament.

* Averaged over any period of 30 seconds maximum.

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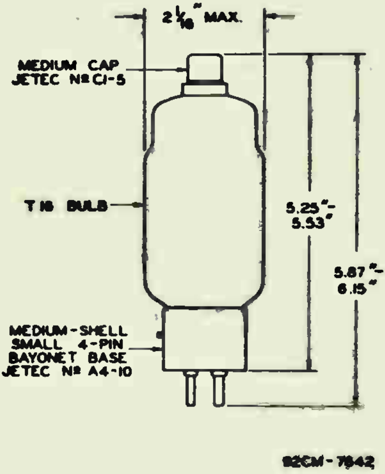
3B28

HALF-WAVE GAS RECTIFIER

Note 3: With 2.5 volts rms on filament, peak anode current of 2 amperes provided by half-cycle pulse from a 60-cps sine wave and recurring approximately once a second. Tube drop is measured by an oscilloscope connected between anode and center tap of filament transformer.

OPERATING NOTES

The filament-supply voltage for the 3B28 may be either in phase or out of phase with the anode voltage. With out-of phase excitation (quadrature operation), improved utilization of the cathode is possible. Although the 3B28 carries no higher anode-current rating for quadrature operation than for in-phase operation, quadrature operation is conducive to appreciably longer tube life. For optimum results, the filament and anode voltages should be 90° out of phase. In practical applications however, nearly, full realization of the advantages of this type of excitation is possible even when the phase difference between the filament and anode supply voltages ranges from the optimum value by as much as ± 30°. In polyphase operation where the anode voltage shifts from one phase to another during the current-conduction period, quadrature operation is obtained when the filament voltage passes through zero at the center of the current-conduction period.



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3B28

HALF-WAVE GAS RECTIFIER

For Circuit Figures, see Front of this Section

CIRCUIT	MAX. TRANS. SEC. VOLTS (RMS) E	APPROX. DC OUTPUT VOLTS TO FILTER E_{av}	MAX. DC OUTPUT AMPERES I_{av}	MAX. DC OUTPUT KW TO FILTER P_{dc}
Fig. 1 Half-Wave Single-Phase In-Phase Operation	7000▲ 3500●	3200 1600	0.25 0.5	0.8 0.8
Fig. 2 Full-Wave Single-Phase In-Phase Operation	3500▲ 1700●	3200 1600	0.5 1.0	1.6 1.6
Fig. 3 Series Single-Phase In-Phase Operation	7000▲ 3500●	6400 3200	0.5 1.0	3.2 3.2
Fig. 4 Half-Wave Three-Phase In-Phase Operation	4000▲ 2000●	4800 2400	0.75 1.5	3.6 3.6
Fig. 5 Parallel Three-Phase Quadrature Operation	4000▲ 2000●	4800 2400	1.5 3.0	7.2 7.2
Fig. 6 Series Three-Phase Quadrature Operation	4000▲ 2000●	9600 4800	0.75 1.5	7.2 7.2
Fig. 7 Half-Wave Four-Phase Quadrature Operation	3500▲ 1700●	4500 2250	*Resistive Load*: 0.9 / 1.8 *Inductive Load*: 1.0 / 2.0	*Resistive Load*: 4.0 / 4.0 *Inductive Load*: 4.5 / 4.5
Fig. 8 Half-Wave Six-Phase Quadrature Operation	3500▲ 1700●	4800 2400	*Resistive Load*: 0.95 / 1.9 *Inductive Load*: 1.0 / 2.0	*Resistive Load*: 4.5 / 4.5 *Inductive Load*: 4.8 / 4.8

▲ For maximum peak inverse anode voltage of 10000 volts.
● For maximum peak inverse anode voltage of 5000 volts.

Beam Power Tube

FORCED-AIR COOLED

GENERAL DATA

Electrical:

Filament, Thoriated Tungsten:		
Voltage (AC or DC)	5 ± 5%	volts
Current at 5 volts	14.5	amp
Transconductance, for plate volts = 2500, grid-No.2 volts = 500, and plate ma. = 100	4000	μmhos
Mu-Factor, Grid No.2 to Grid No.1	5.1	
Direct Interelectrode Capacitances (Approx.):		
Grid No.1 to plate	0.12	μμf
Grid No.1 to filament, grid No.2, and base shell	13	μμf
Plate to filament, grid No.2, and base shell	4.6	μμf

Mechanical:

Operating Position	Vertical, base down ←
Maximum Overall Length	6-3/8"
Seated Length	5-3/8" ± 1/4"
Maximum Diameter	3-9/16"
Weight (Approx.)	9 oz
Cap	Skirted Small (JEDEC No.C1-22)
Base[a]	Special Metal-Shell Giant 5-Pin
Basing Designation for BOTTOM VIEW	5BK

Pin 1 - Filament
Pin 2 - Grid No.2
Pin 3 - Grid No.1

Pin 4 - Grid No.2
Pin 5 - Filament
Cap - Plate

Thermal: ←

Forced-Air Cooling:
Upward through base toward bulb:
Base-cooling air flow from a small fan or centrifugal blower should be applied simultaneously with filament power. In continuous service 15 cfm at a static pressure of 0.4 inch of water are required through the base when the recommended socket and chimney are used.

Base-Seal Temperature	200 max.	°C
Plate-Seal Temperature	225 max.	°C

← indicates a change.

→ **Components:**

Socket. . . . Johnson 122-275, National HX-100, or equivalent
Chimney . . . . Penta Labs PL-C1, or equivalent
Heat-Radiating Plate Connector. . . Eimac HR-6, or equivalent

AF POWER AMPLIFIER & MODULATOR — Class AB

Maximum CCS[b] Ratings, ***Absolute-Maximum Values:***

DC PLATE VOLTAGE.	4000 max.	volts
DC GRID-No.2 (SCREEN-GRID) VOLTAGE. . .	800 max.	volts
MAX.-SIGNAL DC PLATE CURRENT[c]	350 max.	ma
GRID-No.2 INPUT[c].	35 max.	watts
GRID-No.1 (CONTROL-GRID) INPUT[c]	10 max.	watts
PLATE DISSIPATION[c].	400 max.	watts

PLATE-MODULATED RF POWER AMPLIFIER — Class C Telephony

Carrier conditions per tube for use with a maximum modulation factor of 1

Maximum CCS[b] Ratings, ***Absolute-Maximum Values:***

→ *At frequencies up to 110 Mc*

DC PLATE VOLTAGE.	3200 max.	volts
DC GRID-No.2 VOLTAGE.	600 max.	volts
DC GRID-No.1 VOLTAGE.	-500 max.	volts
DC PLATE CURRENT.	275 max.	ma
GRID-No.2 INPUT	35 max.	watts
GRID-No.1 INPUT	10 max.	watts
PLATE DISSIPATION	270 max.	watts

RF POWER AMPLIFIER & OSCILLATOR — Class C Telegraphy[d] and RF POWER AMPLIFIER — Class C FM Telephony

Maximum CCS[b] Ratings, ***Absolute-Maximum Values:***

At frequencies up to 110 Mc

DC PLATE VOLTAGE.	4000 max.	volts
DC GRID-No.2 VOLTAGE.	600 max.	volts
DC GRID-No.1 VOLTAGE.	-500 max.	volts
DC PLATE CURRENT.	350 max.	ma
GRID-No.2 INPUT	35 max.	watts
GRID-No.1 INPUT	10 max.	watts
PLATE DISSIPATION	400 max.	watts

a Metal base shell should be grounded by means of suitable spring fingers.
b Continuous Commercial Service.
c Averaged over any audio-frequency cycle of sine-wave form.
d Key-down conditions per tube without amplitude modulation. Amplitude modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115 per cent of the carrier conditions.

→ Indicates a change.

RCA

4E27A/5-125B
POWER PENTODE

GENERAL DATA

Electrical:

Filament, Thoriated Tungsten:

Voltage	5.0	ac or dc volts
Current	7.5	amp
Transconductance (Approx.) For plate volts = 2500, grid-No.3 volts = 0, grid-No.2 volts = 500, and plate ma. = 50	2150	μmhos
Mu-Factor, Grid No.2 to Grid No.1	5	

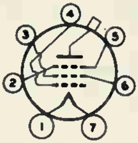
Direct Interelectrode Capacitances:

Grid No.1 to Plate*	0.08	μμf
Input	10.5	μμf
Output	4.7	μμf

Mechanical:

Mounting Position	Vertical, base down
Overall Length	5-15/16" ± 1/4"
Seated Length	5-3/8" ± 1/4"
Maximum Diameter	2-3/4"
Plate Terminal	See Outline Drawing
Base	Ventilated Medium-Metal-Shell Giant 7-Pin
Basing Designation for BOTTOM VIEW	7BM

Pin 1 - Filament
Pin 2 - Grid No.3
Pin 3 - Grid No.2
Pin 4 - Grid No.1
Pin 5 - Same as Pin 2



Pin 6 - Same as Pin 3
Pin 7 - Filament
Bulb Terminal - Plate

Seal Temperature (Plate and stem)	225 max.	°C
Bulb Temperature (At hottest point)	250 max.	°C

Components:

Socket	Johnson No.122-237, or equivalent
Heat-Radiating Plate Connector (Supplied with tube)	Eimac HR-5

AF POWER AMPLIFIER & MODULATOR—Class B

Maximum CCS° Ratings, *Absolute Values*:

Values are per tube

DC PLATE VOLTAGE	4000 max.	volts
DC GRID-No.2 (SCREEN) VOLTAGE	750 max.	volts
DC GRID-No.1 (CONTROL-GRID) VOLTAGE	-500 max.	volts
DC PLATE CURRENT	200 max.	ma
PLATE DISSIPATION	125 max.	watts
GRID-No.3 (SUPPRESSOR) DISSIPATION	20 max.	watts

* With no external shielding and base shell connected to ground.

°: See next page.

RCA

4E27A/5-125B

POWER PENTODE

GRID-No.2 DISSIPATION	20 max.	watts
GRID-No.1 DISSIPATION	5 max.	watts

PLATE-MODULATED RF POWER AMPLIFIER--Class C Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

Maximum CCS° Ratings, *Absolute Values*:

DC PLATE VOLTAGE	3200 max.	volts
DC GRID-No.2 (SCREEN) VOLTAGE	750 max.	volts
DC GRID-No.1 (CONTROL-GRID) VOLTAGE	-500 max.	volts
DC PLATE CURRENT	160 max.	ma
PLATE DISSIPATION	85 max.	watts
GRID-No.3 (SUPPRESSOR) DISSIPATION	20 max.	watts
GRID-No.2 DISSIPATION	20 max.	watts
GRID-No.1 DISSIPATION	5 max.	watts

→ **Typical Operation with Grid No.3 Grounded and Grid-No.2 Volts = 500:**

DC Plate Voltage	2000	2500	volts
DC Grid-No.2 Voltage	500	500	volts
DC Grid-No.1 Voltage	-200	-200	volts
Peak AF Grid-No.2 Voltage	350	350	volts
Peak RF Grid-No.1 Voltage	270	270	volts
DC Plate Current	150	152	ma
DC Grid-No.2 Current	17	17	ma
DC Grid-No.1 Current (Approx.)	7	7	ma
Driving Power (Approx.)	2	2	watts
Power Output (Approx.)	220	295	watts

RF POWER AMPLIFIER & OSCILLATOR--Class C Telegraphy□ and RF POWER AMPLIFIER--Class C FM Telephony

Maximum CCS° Ratings, *Absolute Values*:

DC PLATE VOLTAGE	4000 max.	volts
DC GRID-No.2 (SCREEN) VOLTAGE	750 max.	volts
DC GRID-No.1 (CONTROL-GRID) VOLTAGE	-500 max.	volts
DC PLATE CURRENT	200 max.	ma
PLATE DISSIPATION	125 max.	watts
GRID-No.3 (SUPPRESSOR) DISSIPATION	20 max.	watts
GRID-No.2 DISSIPATION	20 max.	watts
GRID-No.1 DISSIPATION	5 max.	watts

Typical Operation with Grid No.3 Grounded and Grid-No.2 Volts = 500:

DC Plate Voltage	1000	2000	3000	volts
DC Grid-No.2 Voltage	500	500	500	volts
DC Grid-No.1 Voltage	-120	-150	-200	volts
Peak RF Grid-No.1 Voltage	170	240	270	volts
DC Plate Current	145	200	167	ma

o, □: See next page. →Indicates a change.

TUBE DEPARTMENT
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

4E27A/5-125B

POWER PENTODE

DC Grid-No.2 Current	17	23	12	ma
DC Grid-No.1 Current (Approx.)	6	11	7	ma
Driving Power (Approx.). . . .	1	2.6	1.9	watts
Power Output (Approx.)	90	275	375	watts

Typical Operation with Grid No.3 Grounded and Grid-No.2 Volts = 750:

DC Plate Voltage	1000	2000	3000	volts
DC Grid-No.2 Voltage	750	750	750	volts
DC Grid-No.1 Voltage	-170	-200	-250	volts
Peak RF Grid-No.1 Voltage. . .	205	257	290	volts
DC Plate Current	160	200	167	ma
DC Grid-No.2 Current	21	22	9	ma
DC Grid-No.1 Current (Approx.)	3	6	3	ma
Driving Power (Approx.). . . .	0.6	1.5	0.9	watts
Power Output (Approx.)	115	300	375	watts

Typical Operation with Grid-No.3 Volts = 60 and Grid-No.2 Volts = 500:

DC Plate Voltage	1000	2000	3000	volts
DC Grid-No.3 Voltage	60	60	60	volts
DC Grid-No.2 Voltage	500	500	500	volts
DC Grid-No.1 Voltage	-120	-150	-200	volts
Peak RF Grid-No.1 Voltage. . .	170	222	260	volts
DC Plate Current	167	200	167	ma
DC Grid-No.3 Current	6	4	3	ma
DC Grid-No.2 Current	11	11	5	ma
DC Grid-No.1 Current (Approx.)	6	8	6	ma
Driving Power (Approx.). . . .	1	1.8	1.6	watts
Power Output (Approx.)	120	300	375	watts

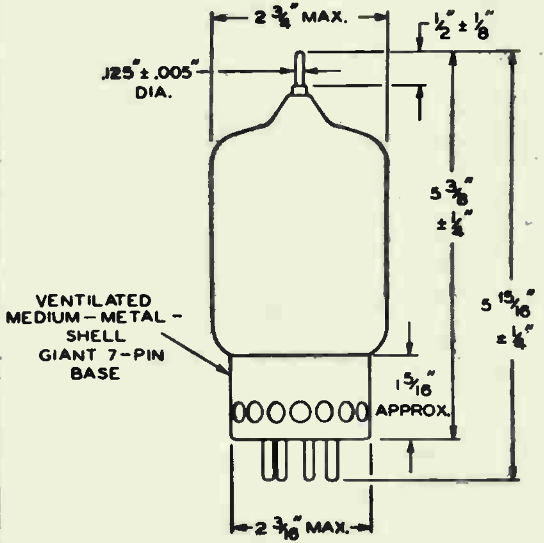
° Continuous Commercial Service.

▫ Key-down conditions per tube without amplitude modulation. Amplitude modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

The 4E27A/5-125B may be operated with maximum rated plate voltage and plate input at frequencies up to 75 megacycles per second

4E27A/5-125B

POWER PENTODE



TUBE DEPARTMENT
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Beam Power Tube

FORCED-AIR COOLED — **GROUNDED-GRID TYPE**

GENERAL DATA

Electrical:

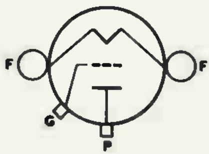
Filament, Multistrand Thoriated Tungsten:		
Excitation	DC or Single Phase AC	
Voltage (AC or DC)	6.0	volts
Current	285	amp
Cold Resistance	0.0025	ohms
Amplification Factor	32	
Direct Interelectrode Capacitances (Approx.): ←		
Grid to plate	34.0	pf
Grid to filament	60.0	pf
Plate to filament	1.0	pf

Mechanical:

Operating Position	Vertical, filament end up
Maximum Overall Length	17-3/8"
Maximum Diameter	14-1/4"
Weight (Approx.)	85 lbs ←
Radiator	Integral part of tube
Mounting	Special

Terminal Diagram (See *Dimensional Outline*):

F - Filament
G - Grid



P - Plate

Thermal: ←

Air Flow:

Upward through radiator	1000 min.	cfm

The specified air flow at a pressure of 2.1 inches of water should be delivered by a blower vertically upward through the radiator before and during the application of any voltages.

To filament seals	10	cfm

The specified air flow must be directed into the filament header before and during the application of any voltages in order to limit the temperature of the filament and grid seals to the maximum value.

Incoming Air Temperature	45 max.	°C
Radiator Temperature	210 max.	°C
Bulb Temperature	180 max.	°C
Seal Temperature (Filament, grid, and plate)	165 max.	°C

← indicates a change.

AF POWER AMPLIFIER and MODULATOR — Class B

Maximum CCS[a] Ratings, ***Absolute-Maximum Values:***

DC PLATE VOLTAGE	11500	max.	volts
MAX.-SIGNAL DC PLATE CURRENT[b]	4	max.	amp
MAX.-SIGNAL PLATE INPUT[b]	40	max.	kw
PLATE DISSIPATION[b]	17.5	max.	kw

Typical Operation:

Values are for 2 tubes

DC Plate Voltage	10500	volts
DC Grid Voltage	-250	volts
Peak AF Grid-to-Grid Voltage	1310	volts
Zero-Signal DC Plate Current	1.7	amp
Max.-Signal DC Plate Current	7	amp
Effective Load Resistance (plate to plate)	3300	ohms
Max.-Signal Driving Power (Approx.)	1500	watts
Max.-Signal Power Output (Approx.)	50	kw

PLATE-MODULATED RF POWER AMPLIFIER — Class C Telephony

Carrier conditions per tube for use with a maximum modulation factor of 1

Maximum CCS[a] Ratings, ***Absolute-Maximum Values:***

DC PLATE VOLTAGE	9000	max.	volts
DC GRID VOLTAGE	-2000	max.	volts
DC PLATE CURRENT	3.2	max.	amp
DC GRID CURRENT	0.65	max.	amp
PLATE INPUT	26	max.	kw
PLATE DISSIPATION	11.5	max.	kw

Typical Operation in Grounded-Filament Circuit:

DC Plate Voltage	8000	volts
DC Grid Voltage:[c]		
From a grid resistor of:		
1280 ohms	-650	volts
Peak RF Grid Voltage	1100	volts
DC Plate Current	2.5	amp
DC Grid Current (Approx.)[d]	0.51	amp
Driving Power (Approx.)[d]	510	watts
Power Output (Approx.)	15.8	kw

Typical Operation in Grounded-Grid Circuit:

Same values as for Grounded-Filament Circuit with the following exceptions:

Driving Power (Approx.)[e]	3000	watts
Power Output (Approx.)	18	kw

RF POWER AMPLIFIER & OSCILLATOR — Class C Telegraphy[f]

Maximum CCS[a] Ratings, ***Absolute-Maximum Values:***

DC PLATE VOLTAGE	11500	max.	volts
DC GRID VOLTAGE	-2000	max.	volts
DC PLATE CURRENT	4	max.	amp
DC GRID CURRENT	0.65	max.	amp
PLATE INPUT	40	max.	kw
PLATE DISSIPATION	17.5	max.	kw

Typical Operation in Grounded-Filament Circuit:

DC Plate Voltage	10000	11000	volts
DC Grid Voltage:[g]			
From a grid resistor of:			
860 ohms	-500	–	volts
900 ohms	–	-540	volts
From a cathode resistor of:			
125 ohms	-500	–	volts
130 ohms	–	-540	volts
Peak RF Grid Voltage	1000	1050	volts
DC Plate Current	3.5	3.6	amp
DC Grid Current (Approx.)[d]	0.58	0.61	amp
Driving Power (Approx.)[d]	515	575	watts
Power Output (Approx.)	25	29.5	kw

Typical Operation in Grounded-Grid Circuit:

Same values as for Grounded-Grid Circuit with the following exceptions:

Driving Power (Approx.)	3400	3750	watts
Power Output (Approx.)	28	32.5	kw

[a] Continuous Commercial Service.

[b] Averaged over any audio-frequency cycle of sine-wave form.

[c] Obtained from a fixed supply, grid resistor, or a combination of both.

[d] For effect of load resistance on grid current and driving power, refer to TUBE RATINGS — *Grid Current and Driving Power* in the General Section.

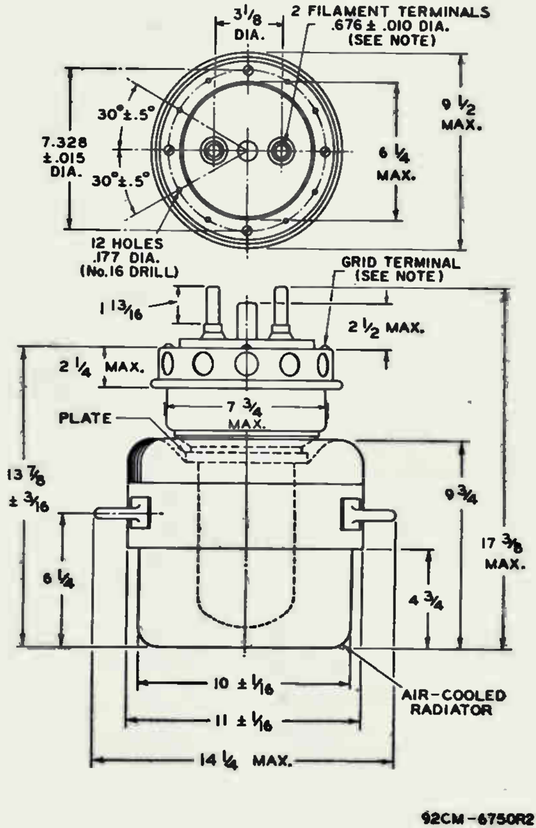
[e] Carrier power of driver modulated 100 per cent.

[f] Key-down conditions per tube without amplitude modulation. Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115 per cent of the carrier conditions.

[g] Obtained from a fixed supply, a cathode resistor, a grid resistor, or from a combination of a fixed supply and self-bias.

MAXIMUM RATINGS vs OPERATING FREQUENCY

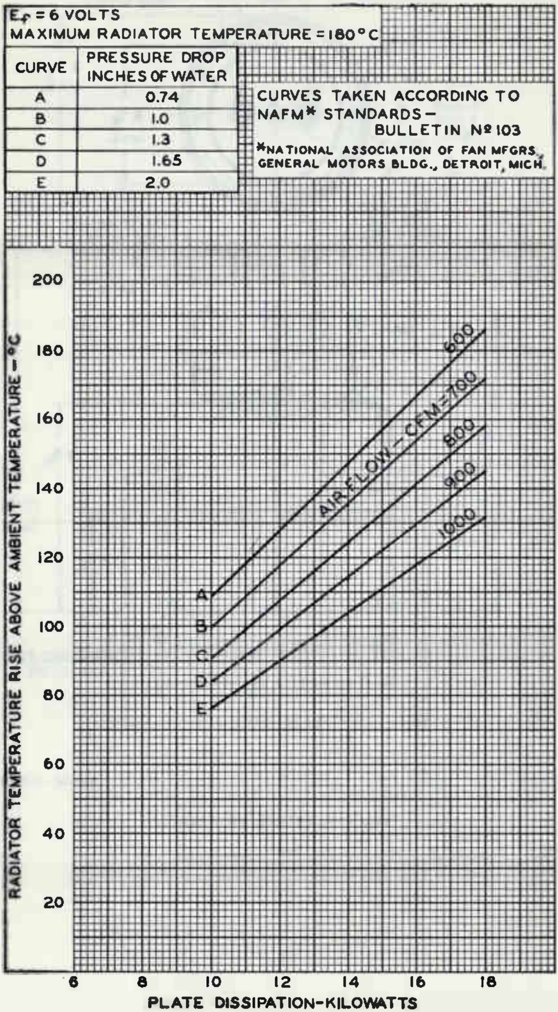
OPERATING FREQUENCY Mc	MAXIMUM PERMISSIBLE PERCENTAGE OF MAXIMUM-RATED PLATE VOLTAGE & PLATE INPUT		
	TELEPHONY		TELEGRAPHY
	Class B, Class C Grid or Suppressor Modulated	Class C Plate-Modulated	Class C Unmodulated
30	100	100	100
50	93	87	87
75	87	74	74
100	80	61	61



ALL DIMENSIONS IN INCHES

NOTE: FLEXIBLE CONNECTIONS ARE REQUIRED.

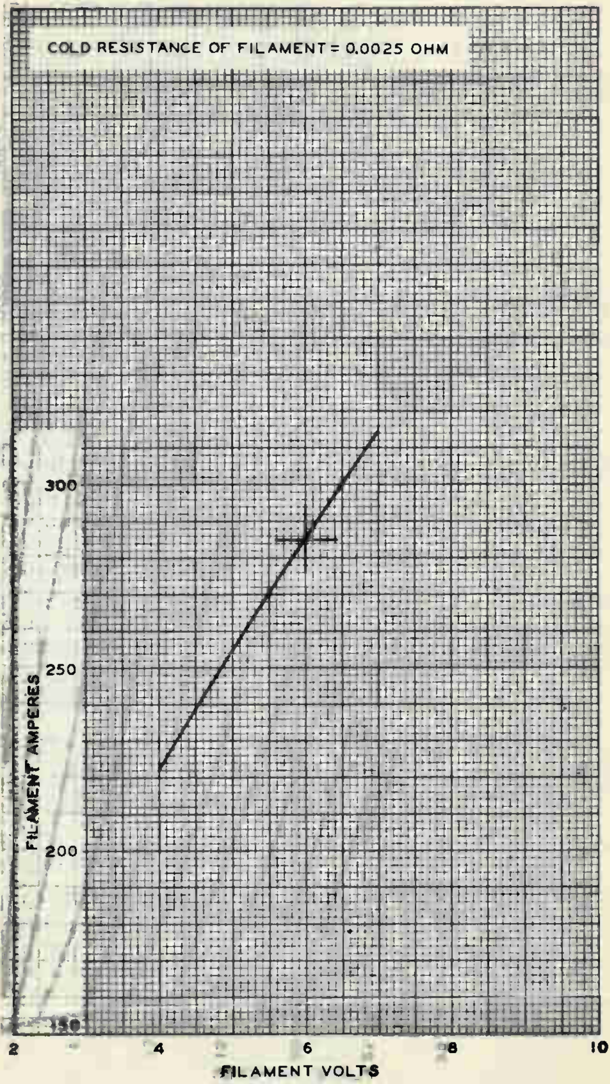
COOLING REQUIREMENTS



92CM-6761

9C25

9C25
AVERAGE FILAMENT CHARACTERISTIC



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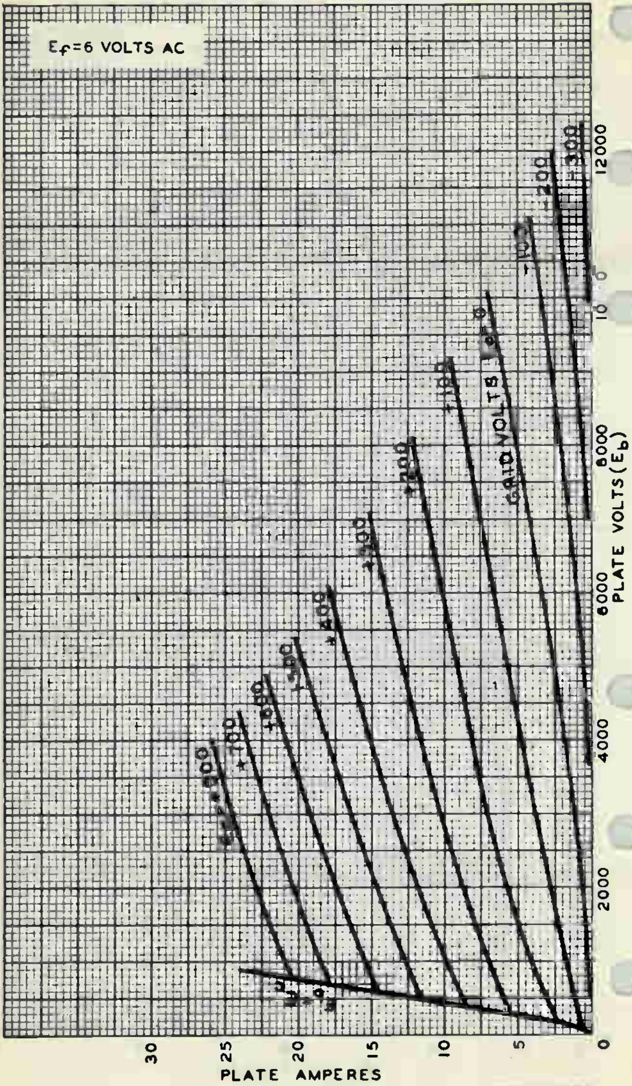
9C25

AVERAGE PLATE CHARACTERISTICS



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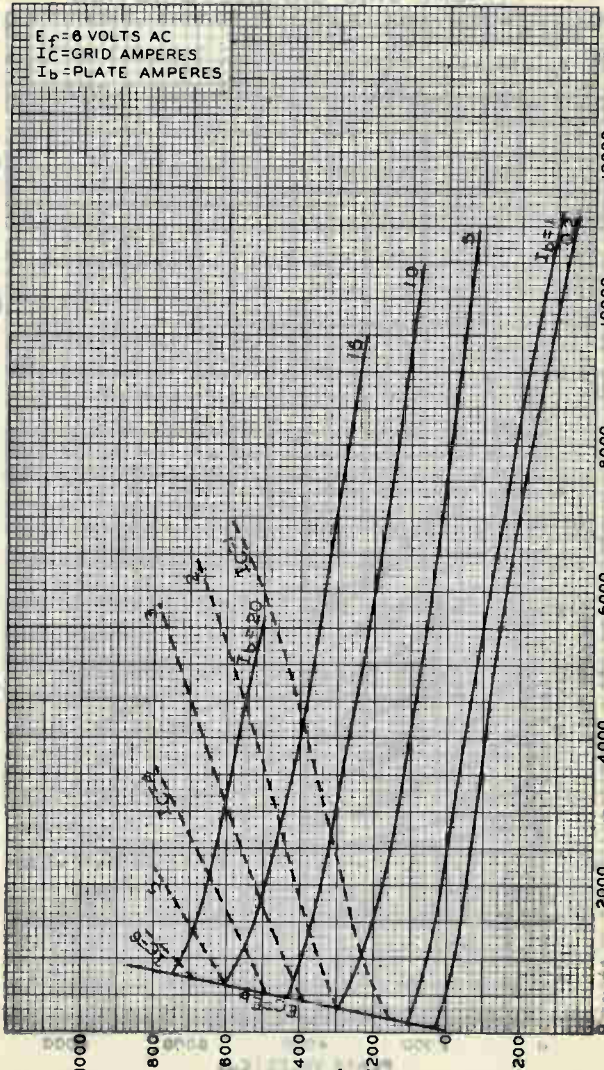
9C25

AVERAGE CONSTANT-CURRENT CHARACTERISTICS



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92CM-7234

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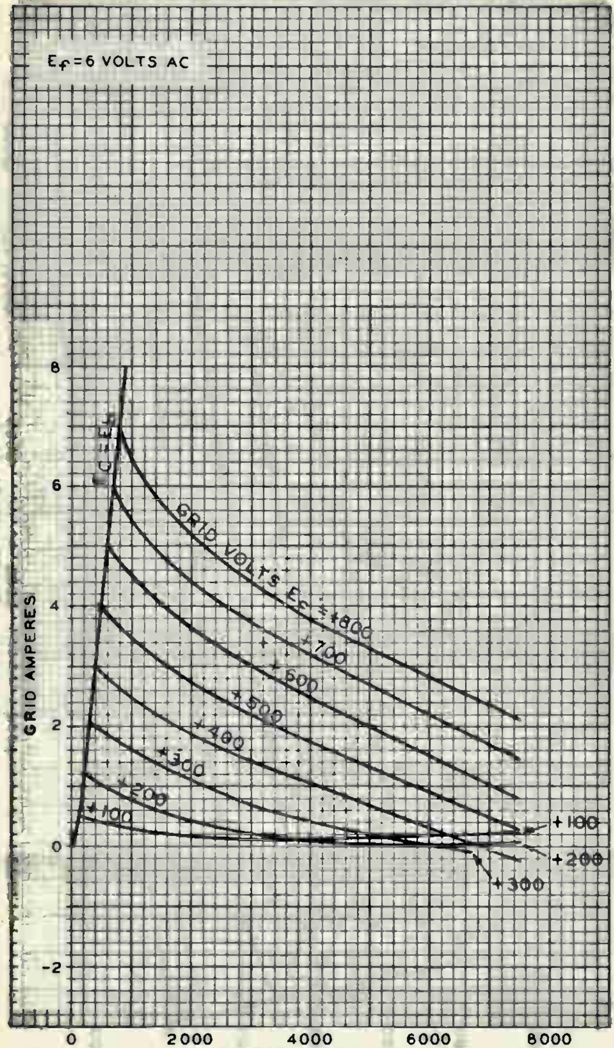
9C25
TYPICAL GRID CHARACTERISTICS



575-A

575-A

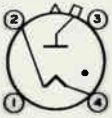
HALF-WAVE MERCURY-VAPOR RECTIFIER

The 575-A is the same as the 673 except for the following items:

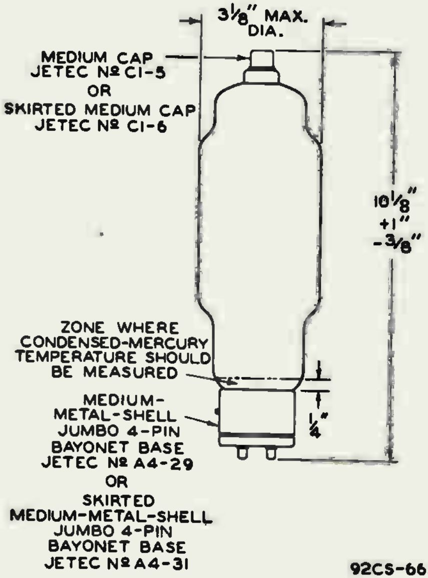
Mechanical:

Overall Length	10-1/8" + 1" - 3/8" ←
Maximum Diameter	3-1/8" ←
Weight (Approx.)	10.8 oz ←
Cap	Medium (JETEC No.C1-5), or Skirted Medium (JETEC No.C1-6) ←
Base	Medium-Metal-Shell Jumbo 4-Pin with Bayonet (JETEC No.A4-29), or Skirted Medium-Metal-Shell Jumbo 4-Pin with Bayonet (JETEC No.A4-31) ←
Basing Designation for BOTTOM VIEW	4AT

Pin 1 – No Connection
Pin 2 – Filament, Cathode Shield



Pin 3 – No Connection
Pin 4 – Filament
Cap – Anode



92CS-6654R2

← Indicates a change.

Half-Wave Vacuum Rectifier

HIGH-VOLTAGE, LOW-CURRENT TYPE

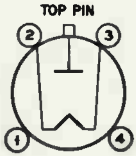
GENERAL DATA

Electrical:

Filament, Thoriated Tungsten:		
Voltage (AC)	2.5 ± 5%	volts
Current at filament volts = 2.5	6	amp

Mechanical:

Operating Position. . . . . Vertical, base down or up
Overall Length. . . . . 7-3/16" ± 1/4"
Maximum Diameter. . . . . 2-1/8" ←
Bulb. T16
Plate Terminal. . 0.050"-Diameter Pin Located at Top of Bulb
Base. . . . . Medium-Shell Super-Jumbo 4-Pin (JEDEC No.A4-16)
Basing Designation for BOTTOM VIEW. 70



Pin 1 - No Internal Connection
Pin 2 - Filament
Pin 3 - Filament
Pin 4 - No Internal Connection
TOP PIN - Plate

HALF-WAVE RECTIFIER

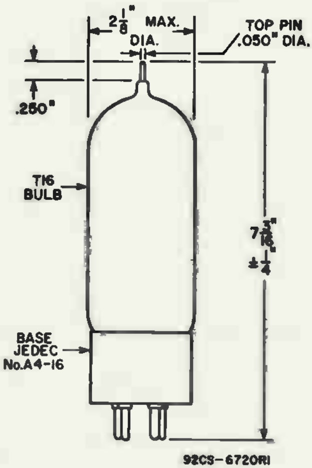
Maximum Ratings, *Absolute-Maximum Values:*

PEAK INVERSE PLATE VOLTAGE.	20000 max.	volts
PLATE CURRENT:		
Peak.	270 max.	ma
Average	25 max.	ma
AMBIENT TEMPERATURE	50 max.	°C
BULB TEMPERATURE.	75 max.	°C

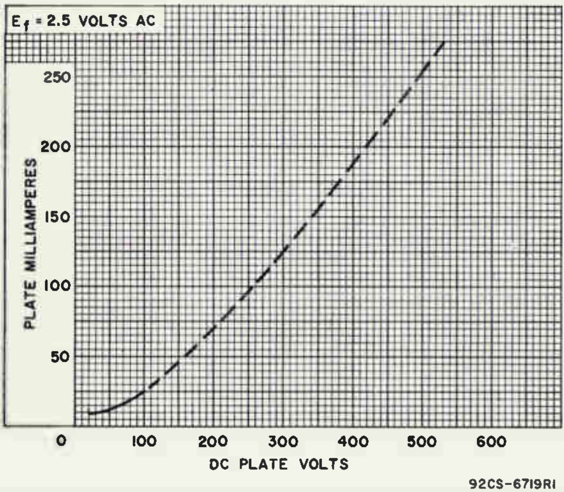
OPERATING CONSIDERATIONS ←

X-Radiation Warning. X radiation is produced when the 579B is operated with a peak inverse plate voltage above 16,000 volts (Absolute-Maximum value). This radiation can constitute a health hazard unless the tube is adequately shielded for X radiation.

← Indicates a change.



AVERAGE PLATE CHARACTERISTIC



Full-Wave Gas and Mercury-Vapor Rectifier

GENERAL DATA

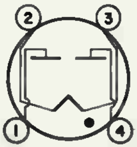
Electrical:[a]

Filament, Coated:		
Voltage (AC)	2.5	volts
Current at 2.5 volts	11.5 ± 1.0	amp
Minimum heating time prior to tube conduction	15	sec
Typical Anode Starting Voltage	10	volts
Peak Tube Voltage Drop at anode amperes = 5	10	volts

Mechanical:

Operating Position . . . . Vertical, base down
Maximum Overall Length . . . . 7-1/2"
Maximum Diameter . . . . 2-1/16"
Weight (Approx.) . . . . 5 oz
Bulb T16
Socket . . . . Super-Jumbo 4-Contact
Base . . . . .Medium-Metal-Shell Super-Jumbo 4-Pin (JEDEC No.A4-81)
Basing Designation for BOTTOM VIEW 4BS

Pin 1 - Anode No.2
Pin 2 - Filament



Pin 3 - Filament
Pin 4 - Anode No.1

Thermal:

Type of Cooling .Convection
Temperature Rise of Condensed Mercury to Equilibrium Above Ambient Temperature (Approx.):

No load	18	°C
Full load	28	°C

FULL-WAVE RECTIFIER[a]

Maximum and Minimum Ratings, ***Absolute-Maximum Values:***

For power-supply frequency of 60 cps

PEAK INVERSE ANODE VOLTAGE	900 max.	volts
ANODE CURRENT (Each Anode):		
Peak	10 max.	amp
Average[b]	2.5 max.	amp
Fault	150 max.	amp
CONDENSED-MERCURY TEMPERATURE RANGE (Operating)[c]	0 to +90	°C

a With circuit returns to filament-transformer center-tap.

b Averaged over any interval of 5 seconds maximum.

c For longest life, the operating condensed-mercury temperature range after warm-up should be kept between +40° and +90° C which corresponds approximately to +15° to +65° C ambient.

Half-Wave Mercury-Vapor Rectifier

GENERAL DATA

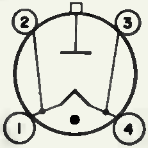
Electrical:[a]

Filament, Coated:		
Voltage (AC)	2.5	volts
Current at 2.5 volts	7 ± 1	amp
Minimum heating time prior to tube conduction	20	sec
Typical Anode Starting Voltage	13	volts
Peak Tube Voltage Drop at anode amperes = 8	12	volts

Mechanical:

Operating Position	Vertical, base down
Maximum Overall Length	6-3/8"
Maximum Diameter	2-1/16"
Weight (Approx.)	4 oz
Bulb	ST16
Cap	Medium (JEDEC No.C1-5)
Socket	Small 4-Contact
Base	Medium-Shell Small 4-Pin with Bayonet (JEDEC No.A4-10)
Basing Designation for BOTTOM VIEW	4AU

Pin 1 – Filament
Pin 2 – Filament
Pin 3 – Filament



Pin 4 – Filament
Cap – Anode

Thermal:

Type of Cooling	Convection	
Temperature Rise of Condensed Mercury to Equilibrium Above Ambient Temperature (Approx.)	30	°C

HALF-WAVE RECTIFIER[a]

Maximum and Minimum Ratings, *Absolute-Maximum Values:*

For power-supply frequency of 60 cps

PEAK INVERSE ANODE VOLTAGE	2000 max.	volts
ANODE CURRENT:		
Peak	10 max.	amp
Average[b]	2.5 max.	amp
Fault	250 max.	amp
CONDENSED-MERCURY TEMPERATURE RANGE (Operating)	+35 to +80	°C

[a] With circuit returns to filament-transformer center-tap.
[b] Averaged over any interval of 5 seconds maximum.

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HALF-WAVE MERCURY-VAPOR RECTIFIER

GENERAL DATA

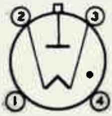
Electrical:

Filament, Coated:		
Voltage	5 ± 5%	ac volts
Current at 5 volts	10	amp
Minimum heating time at rated voltage	30	sec
Peak Tube Voltage Drop (Approx.)	10	volts

Mechanical:

Operating Position	Vertical, base down
Maximum Overall Length	11-7/16" ←
Seated Length	9-9/16" + 1-1/16" - 1/4" ←
Maximum Diameter	3-1/8" ←
Weight (Approx.)	10.8 oz ←
Cap	Medium (JETEC No.C1-5)
Base	Large-Metal-Shell Super-Jumbo 4-Pin with Bayonet (JETEC No.A4-18)
Basing Designation for BOTTOM VIEW	2P

Pin 1 – No Connection
Pin 2 – Filament, Cathode Shield



Pin 3 – Filament
Pin 4 – No Connection
Cap – Anode

Temperature Control:

Heating--When the ambient temperature is so low that the normal rise of condensed-mercury temperature above the ambient temperature will not bring the condensed-mercury temperature up to the minimum value of the operating ranges specified under *Maximum Ratings*, some form of heat-conserving enclosure or auxiliary heater will be required.

Cooling--When the operating conditions are such that the maximum value of the operating condensed-mercury-temperature range is exceeded, provision should be made for forced-air cooling sufficient to prevent exceeding the maximum value.

Temperature Rise of Condensed Mercury to Equilibrium Above Ambient Temperature (Approx.):		
No load*	12	°C
Full load▲	17.5	°C

* With 4.75 volts rms on filament, and no heat-conserving enclosure.

▲ With 5.25 volts rms on filament, quadrature operation, average anode current = 2.5 amperes, and no heat-conserving enclosure.

← Indicates a change.

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HALF-WAVE MERCURY-VAPOR RECTIFIER

HALF-WAVE RECTIFIER — In-Phase Operation●

Maximum Ratings, *Absolute Values: For supply frequency of 60 cps*

	Operating Condensed-Mercury-Temperature Range		
	20° to 60° C	20° to 50° C	
PEAK INVERSE ANODE VOLTAGE.	10000 max.	15000 max.	volts
ANODE CURRENT:			
Peak	7 max.	6 max.	amp
Average**.	1.75 max.	1.5 max.	amp
Fault, for duration of 0.1 second maximum . . .	100 max.	100 max.	amp

HALF-WAVE RECTIFIER — Quadrature Operation●●

Maximum Ratings, *Absolute Values: For supply frequency of 60 cps*

	Operating Condensed-Mercury-Temperature Range		
	20° to 60° C	20° to 50° C	
PEAK INVERSE ANODE VOLTAGE.	10000 max.	15000 max.	volts
ANODE CURRENT:			
Peak	10 max.	10 max.	amp
Average**.	2.5 max.	2.5 max.	amp
Fault, for duration of 0.1 second maximum . . .	100 max.	100 max.	amp

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

	Note	*Min.*	*Max.*	
Filament Current	1	-	11.5	amp
Critical Anode Voltage .	2	-	100	volts
Peak Tube Voltage Drop .	3	-	16	volts

Note 1: With 5 volts rms on filament.

Note 2: With 4.75 volts rms on filament, and condensed-mercury temperature at 20° C.

Note 3: With 5 volts rms on filament, condensed-mercury temperature of 35° ± 5° C, peak anode current of 20 amperes provided by half-cycle pulse from a 60-cps sine wave and recurring approximately once a second. Tube drop is measured by an oscilloscope connected between anode and center-tap of filament transformer.

● Filament voltage in phase with anode voltage.

** Averaged over any interval of 20 seconds maximum.

●● Filament voltage out of phase (60° to 120°) with anode voltage.

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RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

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HALF-WAVE MERCURY-VAPOR RECTIFIER

For Circuit Figures, see Front of this Section

<table>
<tr><th>CIRCUIT</th><th>MAX. TRANS. SEC. VOLTS (RMS)
E</th><th>APPROX. DC OUTPUT VOLTS TO FILTER
Eav</th><th colspan="2">MAX. DC OUTPUT AMPERES
Iav</th><th colspan="2">MAX. DC OUTPUT KW TO FILTER
Pdc</th></tr>
<tr><td>Fig. 1
Half-Wave
Single-Phase
In-Phase Operation</td><td>10600□
7000▲</td><td>4800
3200</td><td colspan="2">1.50
1.75</td><td colspan="2">7.1
5.5</td></tr>
<tr><td>Fig. 2
Full-Wave
Single-Phase
In-Phase Operation</td><td>5300□
3500▲</td><td>4800
3200</td><td colspan="2">3.00
3.50</td><td colspan="2">14.2
11.0</td></tr>
<tr><td>Fig. 3
Series
Single-Phase
In-Phase Operation</td><td>10600□
7000▲</td><td>9600
6400</td><td colspan="2">3.00
3.50</td><td colspan="2">28.4
22.0</td></tr>
<tr><td>Fig. 4
Half-Wave
Three-Phase
In-Phase Operation</td><td>6100□
4000▲</td><td>7200
4800</td><td colspan="2">4.50
5.25</td><td colspan="2">32.2
25.0</td></tr>
<tr><td>Fig. 5
Parallel
Three-Phase
Quadrature Operation</td><td>6100□
4000▲</td><td>7200
4800</td><td colspan="2">15.0
15.0</td><td colspan="2">108
72</td></tr>
<tr><td>Fig. 6
Series
Three-Phase
Quadrature Operation</td><td>6100□
4000▲</td><td>4300
9600</td><td colspan="2">7.5
7.5</td><td colspan="2">108
72</td></tr>
<tr><td>Fig. 7
Half-Wave
Four-Phase
Quadrature Operation</td><td>5300□
3500▲</td><td>6750
4500</td><td>Resistive Load
9.0
9.0</td><td>Inductive Load
10.0
10.0</td><td>Resistive Load
60.8
40.5</td><td>Inductive Load
67.5
45.0</td></tr>
<tr><td>Fig. 8
Half-Wave
Six-Phase
Quadrature Operation</td><td>5300□
3500▲</td><td>7200
4800</td><td>Resistive Load
9.5
9.5</td><td>Inductive Load
10.0
10.0</td><td>Resistive Load
68.4
45.6</td><td>Inductive Load
72.0
48.0</td></tr>
</table>

□ For maximum peak inverse anode voltage of 15,000 volts, and condensed-mercury-temperature range of 20° to 50° C.

▲ For maximum peak inverse anode voltage of 10,000 volts, and condensed-mercury-temperature range of 20° to 60° C.

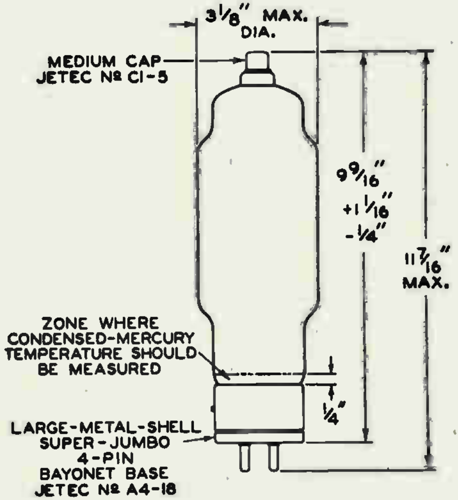
RCA

673

HALF-WAVE MERCURY-VAPOR RECTIFIER

OPERATING CONSIDERATIONS

Shields and rf filter circuits should be provided for the 673 if it is subjected to extraneous high-frequency fields during operation. These fields tend to produce breakdown effects in mercury vapor and are detrimental to tube life and performance. When shields are used, special attention must be given to providing adequate ventilation and to maintaining normal condensed-mercury temperature. Rf filters are employed to prevent damage caused by rf currents which might otherwise be fed back into the rectifier tubes.

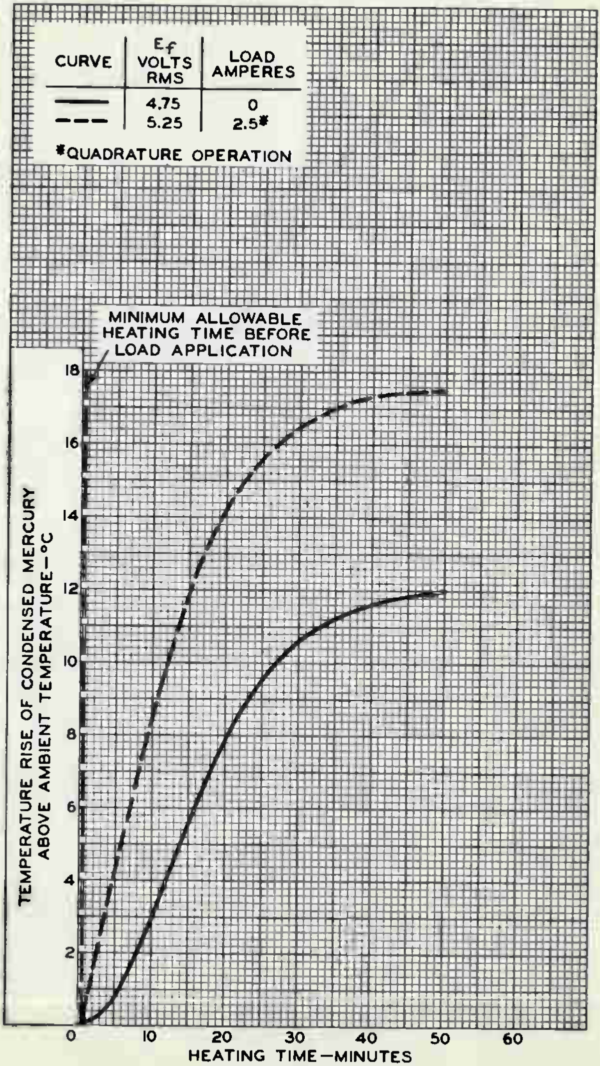


92CS-6655R3

ELECTRON TUBE DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

673

RATE OF RISE OF COND-MERCURY TEMPERATURE



92CM-8824R1

Power Triode

GENERAL DATA

Electrical:

Filament, Thoriated Tungsten:
- Voltage (AC or DC) . . . . 6.3 volts
- Current . . . . 4 amp

Amplification Factor. 160

Direct Interelectrode Capacitances (Approx.):
- Grid to plate . . . . 5.6 pf
- Grid to filament. . . . . 5.9 pf
- Plate to filament . . . . 0.7 pf

Mechanical:

Operating Position. . . . Vertical, base down; or Horizontal, pins 1 & 4 in vertical plane ←

Maximum Overall Length. . . . . 6-15/32"

Seated Length . . . . 5-11/16" ± 5/32"

Maximum Diameter. 2-7/16"

Weight. . . . . 2.7 oz

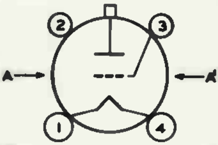
Bulb. ST19

Cap .Medium (JEDEC No.C1-5)

Base. . . . . . . Medium-Shell Small 4-Pin Micanol with Bayonet (JEDEC No.A4-10)

Basing Designation for BOTTOM VIEW. 3G

Pin 1 - Filament
Pin 2 - Do Not Use



Pin 3 - Grid
Pin 4 - Filament
Cap - Plate

AA'=PLANE OF ELECTRODES

AF POWER AMPLIFIER & MODULATOR — Class B

Maximum Ratings, *Absolute-Maximum Values:*

	CCS[a]	ICAS[b]	
DC PLATE VOLTAGE.	1250 max.	1500 max.	volts
MAX.-SIGNAL DC PLATE CURRENT	175 max.	175 max.	ma
MAX.-SIGNAL PLATE INPUT .	165 max.	235 max.	watts
PLATE DISSIPATION[c]. . . .	45 max.	65 max.	watts

Typical Operation:

Values are for two tubes[d]

DC Plate Voltage.	750	1250	1000	1250	1500	volts
DC Grid Voltage[e].	0	0	0	0	-4.5	volts
Peak AF Grid-to-Grid Voltage	197	145	185	175	170	volts
Zero-Signal DC Plate Current	32	50	44	54	32	ma

← Indicates a change.

	CCS		ICAS			
Max.-Signal DC Plate Current	350	260	350	350	313	ma
Effective Load Resistance (Plate to plate).	5100	12400	7400	9200	12400	ohms
Max.-Signal Driving Power (Approx.) . .	9.7	3.8	7.5	6.0	4.4	watts
Max.-Signal Power Output (Approx.). .	178	235	248	310	340	watts

PLATE-MODULATED RF POWER AMPLIFIER — Class C Telephony

Carrier conditions per tube for use with a maximum modulation factor of 1

Maximum Ratings, ***Absolute-Maximum Values:***

	CCS	ICAS	
DC PLATE VOLTAGE.	1000 max.	1250 max.	volts
DC GRID VOLTAGE	-200 max.	-200 max.	volts
DC PLATE CURRENT.	125 max.	150 max.	ma
DC GRID CURRENT	50 max.	50 max.	ma
PLATE INPUT	115 max.	175 max.	watts
PLATE DISSIPATION	30 max.	45 max.	watts

Typical Operation:

	CCS	ICAS	
DC Plate Voltage.	1000	1250	volts
DC Grid Voltage:[f]			
From a grid resistor of:			
1200 ohms	-55	-	volts
2700 ohms	-	-120	volts
Peak RF Grid Voltage.	150	250	volts
DC Plate Current.	115	140	ma
DC Grid Current (Approx.)[g]. . .	45	45	ma
Driving Power (Approx.)[g]. . . .	6.1	10	watts
Power Output (Approx.).	88	135	watts

RF POWER AMPLIFIER & OSCILLATOR — Class C Telegraphy[h]

Maximum Ratings, ***Absolute-Maximum Values:***

	CCS	ICAS	
DC PLATE VOLTAGE.	1250 max.	1500 max.	volts
DC GRID VOLTAGE	-200 max.	-200 max.	volts
DC PLATE CURRENT.	175 max.	175 max.	ma
DC GRID CURRENT	50 max.	50 max.	ma
PLATE INPUT	175 max.	260 max.	watts
PLATE DISSIPATION	45 max.	65 max.	watts

Typical Operation:

	CCS	ICAS	
DC Plate Voltage.	1250	1500	volts
DC Grid Voltage:[j]			
From a grid resistor of:			
1100 ohms	-50	-	volts
1750 ohms	-	-70	volts

From a cathode resistor of:			
270 ohms.	-50	-	volts
330 ohms.	-	-70	volts
Peak RF Grid Voltage.	140	175	volts
DC Plate Current.	140	173	ma
DC Grid Current (Approx.)[g]. . .	45	40	ma
Driving Power (Approx.)[g]. . . .	5.7	7.1	watts
Power Output (Approx.).	135	200	watts

SELF-RECTIFYING AMPLIFIER[k] — Class C

Maximum CCS Ratings, ***Absolute-Maximum Values:***

AC PLATE VOLTAGE (RMS).	1750 max.	volts
DC GRID VOLTAGE	-125 max.	volts
DC PLATE CURRENT.	65 max.	ma
DC GRID CURRENT	25 max.	ma
PLATE INPUT	125 max.	watts
PLATE DISSIPATION	45 max.	watts

Typical Operation in Push-Pull Circuit at 27 Mc:

Values are for 2 tubes

AC Plate Voltage (RMS).	1750	volts
DC Grid Voltage:[f,m]		
From a grid resistor of:		
1500 ohms	-70	volts
DC Plate Current.	130	ma
DC Grid Current (Approx.)	46	ma
Driving Power (Approx.)[n].	12	watts
Power Output (Approx.).	175	watts
Useful Power Output (Approx.)-		
75% circuit efficiency.	130	watts

AMPLIFIER[k] — Class C

With Separate, Rectified, Unfiltered,
Single-Phase, Full-Wave Plate Supply

Maximum CCS Ratings, ***Absolute-Maximum Values:***

DC PLATE VOLTAGE.	1125 max.	volts
DC GRID VOLTAGE	-125 max.	volts
DC PLATE CURRENT.	160 max.	ma
DC GRID CURRENT	45 max.	ma
PLATE INPUT	175 max.	watts
PLATE DISSIPATION	45 max.	watts

Typical Operation:

DC Plate Voltage.	1125	volts
DC Grid Voltage:[f,m]		
From a grid resistor of:		
1400 ohms	-35	volts
DC Plate Current.	125	ma
DC Grid Current (Approx.)	25	ma
Driving Power (Approx.)[k].	3	watts
Power Output (Approx.).	135	watts

LINEAR RF POWER AMPLIFIER — Class AB_2

Single-Sideband Suppressed-Carrier Service

Maximum Ratings, *Absolute-Maximum Values up to 30 Mc:*

	CCS	ICAS	
DC PLATE VOLTAGE	1250 max.	1500 max.	volts
DC PLATE CURRENT:			
Max.-Signal (Single-Tone) or Peak-Envelope (Two-Tone)	175 max.	175 max.	ma
DC GRID CURRENT	50 max.	50 max.	ma
DC PLATE INPUT:			
Max.-Signal (Single-Tone) or Peak-Envelope (Two-Tone)	165 max.	235 max.	watts
PLATE DISSIPATION	45 max.	65 max.	watts

Typical Operation with "Single-Tone" Modulation:[q]

DC Plate Voltage	1250	1500	volts
DC Grid Voltage[r]	0	-4.5	volts
Zero-Signal DC Plate Current	25	16	ma
Effective RF Load Resistance	5700	6000	ohms
DC Plate Current	130	157	ma
DC Grid Current	30	30	ma
Peak RF Grid Voltage	78	88	volts
Driver Power Output, (Approx.)[s]	7	8	watts
Output-Circuit Efficiency (Approx.)	90	90	%
Useful Max.-Signal Power Output (Approx.)	120[t]	160[t]	watts

Typical Operation with "Two-Tone" Modulation at 30 Mc:[u]

DC Plate Voltage	1250	1500	volts
DC Grid Voltage[r]	0	-4.5	volts
Zero-Signal DC Plate Current	25	16	ma
Effective RF Load Resistance	5700	6000	ohms
DC Plate Current:			
Peak-Envelope	130	157	ma
Average	91	110	ma
Average DC Grid Current	20	20	ma
Peak-Envelope Driver Power Output (Approx.)[s]	7	8	watts
Output-Circuit Efficiency (Approx.)	90	90	%
Distortion Products Level:[v]			
Third order	-26	-25	db
Fifth order	-32	-30	db
Useful Power Output (Approx.):			
Peak-Envelope	120[t]	160[t]	watts
Average	60[t]	80[t]	watts

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

	Note	Min.	Max.	
Filament Current	1	3.75	4.25	amp
Amplification Factor	1,2	144	176	
Grid-Plate Capacitance	-	4.9	6.3	pf
Grid-Filament Capacitance	-	4.9	6.9	pf

➜ Indicates a change.

Plate-Filament Capacitance.	-	0.52	0.88	pf
Plate Current	1,3	16	36	ma
Grid Current.	1,4	25	85	ma
Useful Power Output	1,5	160	-	watts ←

Note 1: With dc filament voltage of 6.3 volts.

Note 2: With dc plate current of 20 ma. and dc grid voltage of -1 volt.

Note 3: With dc plate voltage of 2000 volts and dc grid voltage of -2 volts.

Note 4: With dc plate voltage of 200 volts and dc grid voltage of +50 volts.

Note 5: With dc plate voltage of 1500 volts; dc plate current of 175 ma; dc grid current of 34 to 50 ma; grid resistor of 3500 ± 10% ohms; and frequency of 15 Mc.

a Continuous Commercial Service.

b Intermittent Commercial and Amateur Service.

c Averaged over any audio-frequency cycle of sine-wave form.

d When two or more tubes are used precautions should be taken to balance the plate currents.

e For ac filament supply.

f Obtained by grid resistor of value shown or by partial self-bias methods.

g For effect of load resistance on grid current and driving power, refer to TUBE RATINGS — *Grid Current and Driving Power* in the General Section.

h Key-down conditions per tube without modulation. Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115 per cent of the carrier conditions.

j Obtained from fixed supply, by grid resistor, by cathode resistor, or by combination methods.

k The 811A is not recommended for oscillator service in applications involving wide variations in load. For such applications, the 812A with its low amplification factor is preferred because of its ability to oscillate over a wide range of load variation.

m The 811A can be biased by any convenient method. However, the use of a grid resistor is preferred because the bias is automatically adjusted as the load on the circuit varies. In those applications, such as are encountered in therapeutic equipment, where grid current and grid voltage may vary widely because of fluctuating loads, it is important to design equipment so that the maximum grid-current and grid-voltage ratings are never exceeded for any load.

n From a self-rectifying driver.

p From a driver with a rectified, unfiltered, single-phase, full-wave plate supply.

q "Single-Tone" operation refers to that class of amplifier service in which the input consists of a monofrequency rf signal having constant amplitude. This signal is produced in a single-sideband suppressed-carrier system when a single audio frequency of constant amplitude is applied to the input of the system.

r Obtained preferably from a separate, well-regulated supply.

s Driver power output represents circuit losses and is the actual power measured at input to the grid circuit. The actual power required depends on the operating frequency and the circuit used.

t This value of useful power is measured at load of output circuit having indicated efficiency.

u "Two-Tone Modulation" operation refers to that class of amplifier service in which the input consists of two equal monofrequency rf signals having constant amplitude. These signals are produced in a single-sideband suppressed-carrier system when two equal-and-constant amplitude audio frequencies are applied to the input of the system.

v Referenced to either of the two tones and without the use of feedback to enhance linearity.

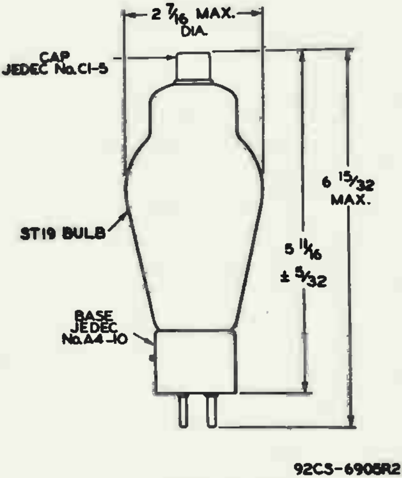
OPERATING CONSIDERATIONS

Plate shows no color when tube is operated at maximum CCS ratings, and shows a barely perceptible red color at maximum ICAS ratings.

← Indicates a change.

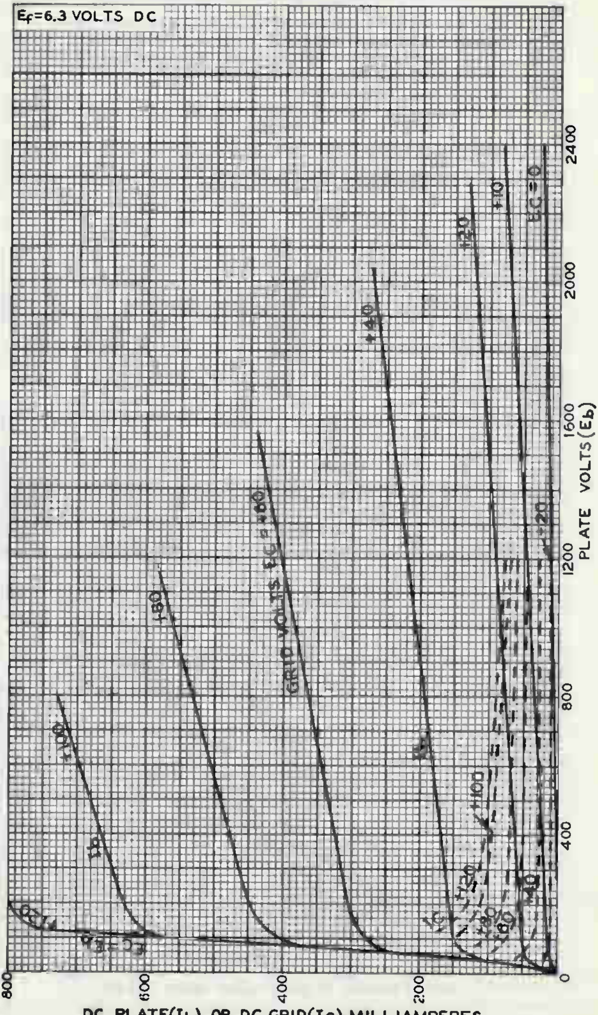
MAXIMUM RATINGS vs OPERATING FREQUENCY

OPERATING FREQUENCY Mc	MAXIMUM PERMISSIBLE PERCENTAGE OF MAXIMUM PLATE VOLTAGE & PLATE INPUT	
	TELEPHONY	TELEGRAPHY
	Class C Plate-Modulated	Class C
30	100	100
60	89	89
80	70	70
100	55	55



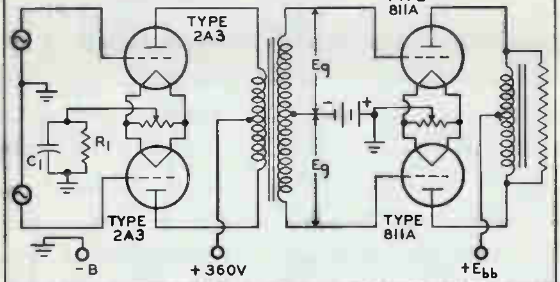
ALL DIMENSIONS IN INCHES

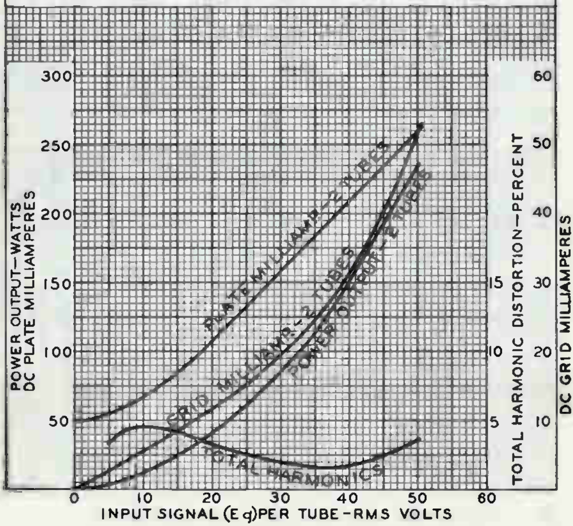
AVERAGE PLATE CHARACTERISTICS



OPERATION CHARACTERISTICS

E_f = 6.3 VOLTS AC FOR 811A's & 2.5 VOLTS AC FOR 2A3's
INPUT: CLASS AB_1–TWO TYPE 2A3's; PLATE-SUPPLY VOLTS = 360; CATHODE-BIAS RESISTOR(R_1) = 780 OHMS; BYPASS CAPACITOR(C_1) = 80 µf
INTERSTAGE TRANSFORMER (T):
VOLTAGE RATIO $\frac{\text{PRIMARY}}{\text{1/2 SEC.}} = 6$
OUTPUT: CLASS B–TWO TYPE 811A's; PLATE-SUPPLY VOLTS (E_{bb}) = 1250; DC GRID VOLTS = 0; PLATE-TO-PLATE LOAD = 12 400 OHMS

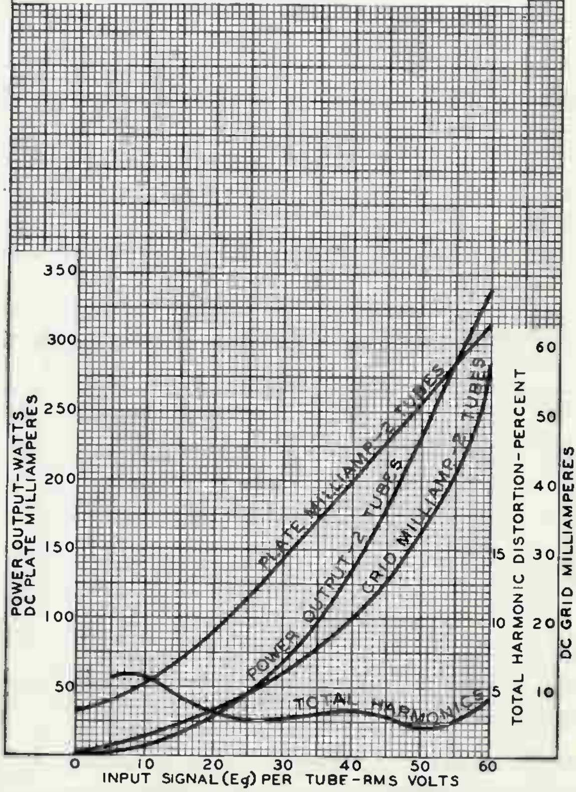




92CM-7138

OPERATION CHARACTERISTICS

E_f = 6.3 VOLTS AC FOR 811A's & 2.5 VOLTS AC FOR 2A3's
CIRCUIT ARRANGEMENT: SAME AS ON DWG. 92CM-7138 UNDER TYPE 811A
INPUT: CLASS AB1-TWO TYPE 2A3's; PLATE-SUPPLY VOLTS = 360; CATHODE-BIAS RESISTOR (R_1) = 780 OHMS; BYPASS CAPACITOR (C_1) = 80 μf
INTERSTAGE TRANSFORMER (T):
VOLTAGE RATIO $\frac{\text{PRIMARY}}{\frac{1}{2}\text{ SEC.}} = 6$
OUTPUT: CLASS B-TWO TYPE 811A's; PLATE-SUPPLY VOLTS (E_{bb}) = 1500; DC GRID VOLTS = −4.5; PLATE-TO-PLATE LOAD = 12400 OHMS



92CM-7139

Power Triode

GENERAL DATA

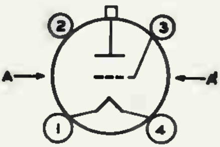
Electrical:

Filament, Thoriated Tungsten:		
Voltage (AC or DC)	6.3 ± 0.3	volts
Current at filament volts = 6.3	4	
Amplification Factor	29	
Direct Interelectrode Capacitances:		
Grid to plate	5.5	pf
Grid to filament	5.4	pf
Plate to filament	0.77	pf

Mechanical:

Operating Position	Vertical, base down; or Horizontal, pins 1 and 4 in vertical plane
Maximum Overall Length	6-15/32"
Seated Length	5-11/16" ± 5/32"
Maximum Diameter	2-7/16"
Weight	2.7 oz
Bulb	ST19
Cap	Medium (JEDEC No.C1-5)
Base	Medium-Shell Small 4-Pin Micanol with Bayonet (JEDEC No.A4-10)
Basing Designation for BOTTOM VIEW	3G

Pin 1 - Filament
Pin 2 - Do Not Use



Pin 3 - Grid
Pin 4 - Filament
Cap - Plate

AA'=PLANE OF ELECTODES

AF POWER AMPLIFIER & MODULATOR — Class B

Maximum Ratings, *Absolute-Maximum Values:*

	CCS●	*ICAS*●●	
DC PLATE VOLTAGE	1250 max.	1500 max.	volts
MAX.-SIGNAL DC PLATE CURRENT*	175 max.	175 max.	ma
MAX.-SIGNAL PLATE INPUT*	165 max.	235 max.	watts
PLATE DISSIPATION*	45 max.	65 max.	watts

Typical Operation:

Values are for 2 tubes

DC Plate Voltage	1250	1500	volts
DC Grid Voltage#	-40	-48	volts
Peak AF Grid-to-Grid Voltage	225	270	volts
Zero-Signal DC Plate Current	22	28	ma

* Averaged over any audio-frequency cycle of sine-wave form.
●, ●●, #: See next page. ← Indicates a change.

	CCS●	ICAS●●	
Max.-Signal DC Plate Current. .	260	310	ma
Effective Load Resistance (plate-to-plate).	12200	13200	ohms
Max.-Signal Driving Power (Approx.)	3.5	5	watts
Max.-Signal Power Output (Approx.)	235	340	watts

PLATE-MODULATED RF POWER AMPLIFIER — Class C Telephony

Carrier conditions per tube for use with a maximum modulation factor of 1

Maximum Ratings, ***Absolute-Maximum Values:***

	CCS●	ICAS●●	
DC PLATE VOLTAGE.	1000 max.	1250 max.	volts
DC GRID VOLTAGE	-200 max.	-200 max.	volts
DC PLATE CURRENT.	125 max.	150 max.	ma
DC GRID CURRENT	35 max.	35 max.	ma
PLATE INPUT	115 max.	175 max.	watts
PLATE DISSIPATION	30 max.	45 max.	watts

Typical Operation:

DC Plate Voltage.	1000	1250	volts
DC Grid Voltage●.	-110	-115	volts
	3400	3300	ohms
Peak RF Grid Voltage.	220	240	volts
DC Plate Current.	115	140	ma
DC Grid Current (Approx.) . . .	33	35	ma
Driving Power (Approx.)	6.6	7.6	watts
Power Output (Approx.).	85	130	watts

RF POWER AMPLIFIER & OSCILLATOR — Class C Telegraphy

Key-down conditions per tube without modulation□□

Maximum Ratings, ***Absolute-Maximum Values:***

	CCS●	ICAS●●	
DC PLATE VOLTAGE.	1250 max.	1500 max.	volts
DC GRID VOLTAGE	-200 max.	-200 max.	volts
DC PLATE CURRENT.	175 max.	175 max.	ma
DC GRID CURRENT	35 max.	35 max.	ma
PLATE INPUT	175 max.	260 max.	watts
PLATE DISSIPATION	45 max.	65 max.	watts

Typical Operation:

DC Plate Voltage.	1250	1500	volts
DC Grid Voltage▲▲	-90	-120	volts
	3000	4000	ohms
	530	590	ohms
Peak RF Grid Voltage.	200	240	volts
DC Plate Current.	140	173	ma
DC Grid Current (Approx.) . . .	30	30	ma
Driving Power (Approx.)	5.4	6.5	watts
Power Output (Approx.).	130	190	watts

●, ●●, #, ⊕, ▲▲, □□: See next page.

812-A
POWER TRIODE

SELF-RECTIFYING OSCILLATOR or AMPLIFIER – Class C

Maximum Ratings, *Absolute Values*:

	CCS●	
AC PLATE VOLTAGE (RMS)	1750 max.	volts
DC GRID VOLTAGE	-125 max.	volts
DC PLATE CURRENT	75 max.	ma
DC GRID CURRENT	20 max.	ma
PLATE INPUT	145 max.	watts
PLATE DISSIPATION	45 max.	watts

Typical Operation in Push-Pull Circuit at 27 Mc.:
Values are for 2 tubes

AC Plate Voltage (RMS)	1740	volts
Grid Resistor●	3500	ohms
DC Plate Current	150	ma
DC Grid Current (at full load)	29	ma
Driving Power (Approx.)▲	12	watts
Power Output (Approx.)	200	watts
Useful Power Output (Approx.)– 75% circuit efficiency	150	watts

AMPLIFIER or OSCILLATOR – Class C ←

With Separate, Rectified, Unfiltered, Single-Phase, Full-Wave Plate Supply

Maximum Ratings, *Absolute Values*:

	CCS●	
DC PLATE VOLTAGE	1125 max.	volts
DC GRID VOLTAGE	-125 max.	volts
DC PLATE CURRENT	160 max.	ma
DC GRID CURRENT	32 max.	ma
PLATE INPUT§	175 max.	watts
PLATE DISSIPATION	45 max.	watts

Typical Operation:

DC Plate Voltage	1125	volts
Grid Resistor●	2200	ohms
DC Plate Current	125	ma
DC Grid Current (Approx.)	30	ma
Driving Power (Approx.)§§	5	watts
Power Output (Approx.)	135	watts

● Continuous Commercial Service.
●● Intermittent Commercial and Amateur Service.
For ac filament supply.
● Obtained by grid resistor of value shown or by partial self-bias methods.
▲▲ Obtained from a fixed supply, by grid resistor (3000, 4000) or by cathode resistor (530, 590).

□□, ▲, ◆, §, §§: See next page. ← Indicates a change.

812-A

812-A
POWER TRIODE

□□ Modulation essentially negative may be used, if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

▲ From a self-rectified driver.

● The 812-A can be biased by any convenient method, but the use of a grid resistor is preferred because the bias is automatically varied as the load on the circuit varies. In those applications where grid current and grid voltage may vary widely because of fluctuating loads, it is important to design equipment so that the maximum grid-current and grid-voltage ratings are never exceeded for any load. An approximate rule is to adjust the grid-current and grid-voltage values at full-load to one-half of the corresponding maximum values. This operating condition permits grid-current and grid-voltage values to rise from zero load to twice their full-load values, and usually provides adequate leeway.

§ Power input to plate is 1.23 times the product of DC Plate Voltage and DC Plate Current.

§§ From a driver with a rectified, unfiltered, single-phase, full-wave plate supply.

NOTE: When the 812-A is used in the final amplifier or a preceding stage of a transmitter designed for break-in operation and oscillator keying, a small amount of fixed bias must be used to maintain the plate current at a safe value. With a plate voltage of 1500 volts, a fixed bias of at least -45 volts should be used.

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

	Note	Min.	Max.	
Filament Current	1	3.75	4.25	amp
Amplification Factor	1,2	26	32	
Grid-Plate Capacitance . . .	-	4.8	6.2	μμf
Grid-Filament Capacitance. .	-	4.4	6.4	μμf
Plate-Filament Capacitance .	-	0.58	0.96	μμf
Grid Current	1,3	17	39	ma
Plate Current.	1,4	18	42	ma
Useful Power Output.	1,5	140	-	watts

Note 1: DC filament voltage = 6.3 volts.

Note 2: With dc grid voltage of -30 volts and plate voltage adjusted to give plate current of 30 ma.

Note 3: With dc plate voltage of 200 volts and dc grid voltage of +50 volts.

Note 4: With dc plate voltage of 1250 volts and dc grid voltage of -30 volts.

Note 5: With dc plate voltage of 1500 volts, plate current of 175 ma., grid current of 34 to 50 ma., grid resistor of 3500 ± 10% ohms and frequency of 15 Mc.

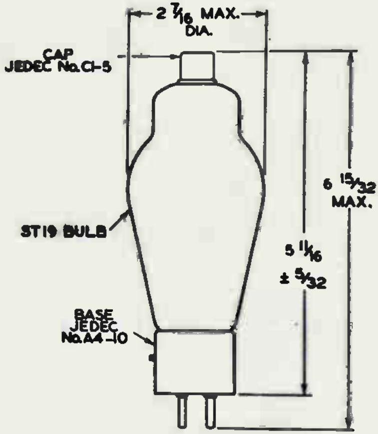
Data on operating frequencies for the 812-A are given on the sheet TRANS. TUBE RATINGS vs FREQUENCY

OPERATING CONSIDERATIONS

Plate shows no color when tube is operated at maximum CCS ratings, and shows a barely perceptible red color at maximum ICAS ratings.

MAXIMUM RATINGS vs OPERATING FREQUENCY

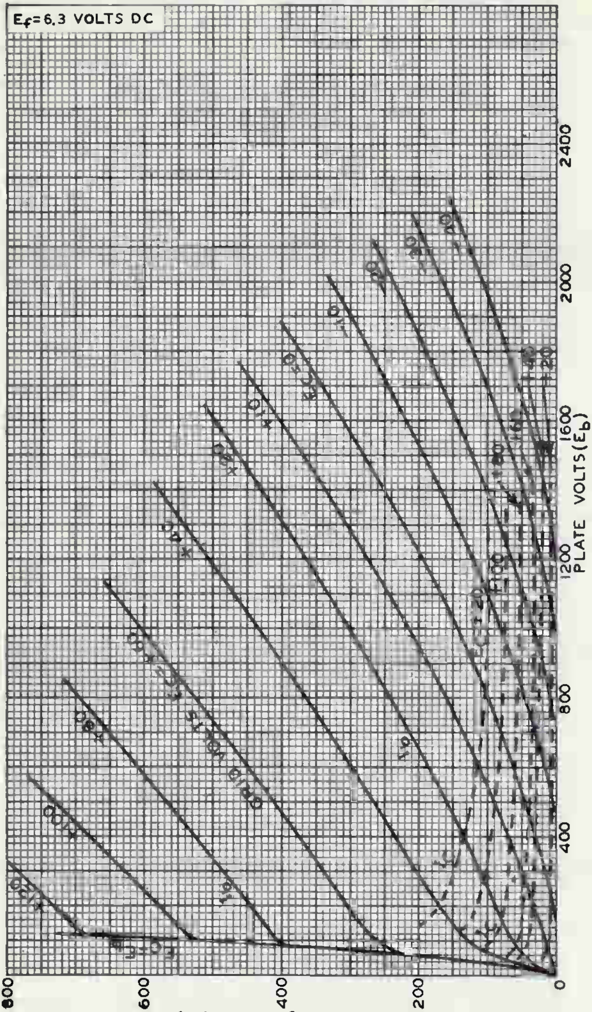
OPERATING FREQUENCY Mc	MAXIMUM PERMISSIBLE PERCENTAGE OF MAXIMUM PLATE VOLTAGE & PLATE INPUT	
	TELEPHONY	TELEGRAPHY
	Class C Plate-Modulated	Class C
30	100	100
60	89	89
80	70	70
100	55	55



92CS-6906R2

ALL DIMENSIONS IN INCHES

AVERAGE PLATE CHARACTERISTICS



92CM-6074R1

RCA

812-A

OPERATION CHARACTERISTICS

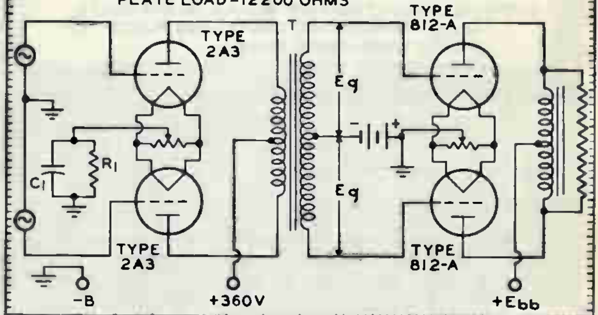
E_f = 6.3 VOLTS AC FOR 812-A's & 2.5 VOLTS AC FOR 2A3's

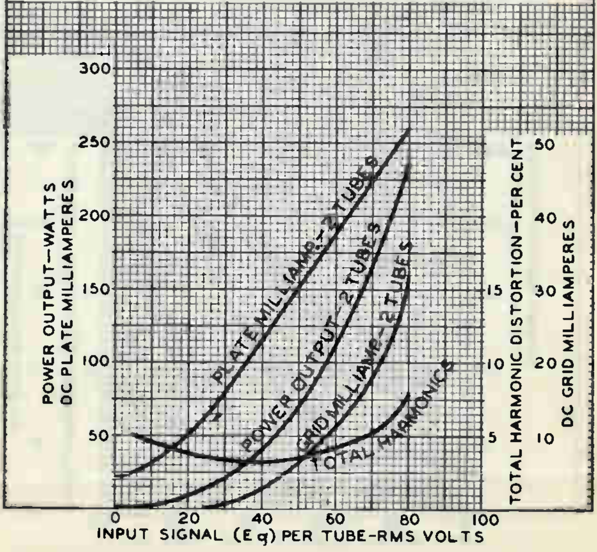
INPUT: CLASS AB_1 — TWO TYPE 2A3's; PLATE-SUPPLY VOLTS = 360; CATHODE-BIAS RESISTOR (R_1) = 780 OHMS; BYPASS CAPACITOR (C_1) = 80 μf

INTERSTAGE TRANSFORMER (T):

VOLTAGE RATIO $\frac{\text{PRIMARY}}{\text{1/2 SEC.}} = 1.4$

OUTPUT: CLASS B — TWO TYPE 812-A's; PLATE VOLTS (E_{bb}) = 1250; DC GRID VOLTS = −40; PLATE-TO-PLATE LOAD = 12200 OHMS



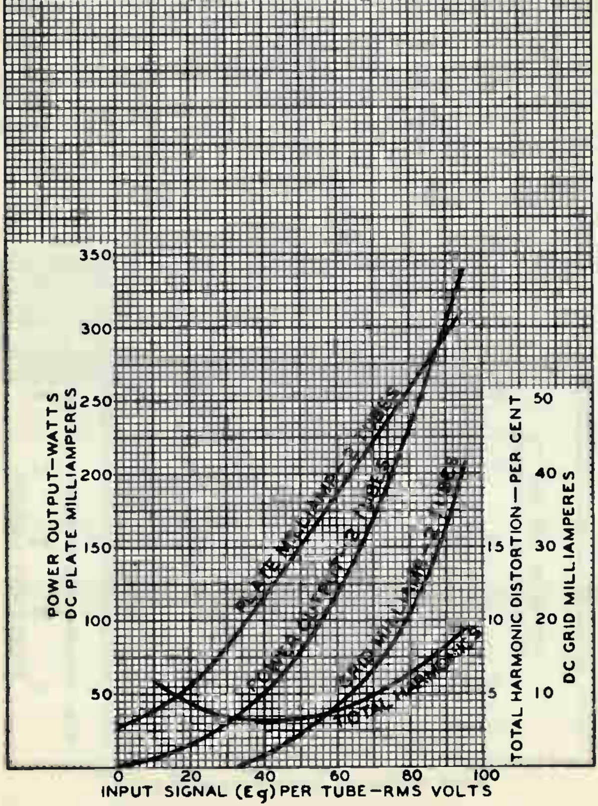


RCA

812-A

OPERATION CHARACTERISTICS

E_f = 6.3 VOLTS AC FOR 812-A's & 2.5 VOLTS AC FOR 2A3's
CIRCUIT ARRANGEMENT: SAME AS ON DWG. 92CM-6938 UNDER TYPE 812-A
INPUT: CLASS AB_1 — TWO TYPE 2A3's; PLATE-SUPPLY VOLTS = 360; CATHODE-BIAS RESISTOR (R_1) = 780 OHMS; BYPASS CAPACITOR (C_1) = 80 μf
INTERSTAGE TRANSFORMER (T):
VOLTAGE RATIO $\frac{\text{PRIMARY}}{1/2 \text{ SEC.}}$ = 1.4
OUTPUT: CLASS B—TWO TYPE 812-A's; PLATE VOLTS (E_{bb}) = 1500; DC GRID VOLTS = -48; PLATE-TO-PLATE LOAD = 13200 OHMS



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HALF-WAVE MERCURY-VAPOR RECTIFIER

GENERAL DATA

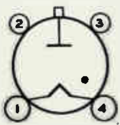
Electrical:

Filament, Coated:	Min.	Av.	Max.	
Voltage	2.25	2.5	2.75	ac volts
Current at 2.5 volts	–	2	2.2	amp
Heating time at rated voltage	10	–	–	sec
Peak Tube Voltage Drop (Approx.)	–	15	–	volts

Mechanical:

Operating Position . . . . Vertical, base down
Maximum Overall Length . . . . 4-11/16"
Seated Length . . . . 3-15/16" ± 1/8"
Maximum Diameter . . . . 1-9/16"
Weight (Approx.) . . . . 1 oz
Bulb ST12
Cap . . . . Small (JETEC No.C1-1)
Socket . . . . Johnson No.122-224, or equivalent
Base . . . . Small-Shell Small 4-Pin (JETEC No.A4-5)
Basing Designation for BOTTOM VIEW 4P

Pin 1 – Filament
Pin 2 – No Connection
Pin 3 – No Connection



Pin 4 – Filament, Cathode Shield
Cap – Anode

Temperature Control:

Heating—When the ambient temperature is so low that the normal rise of condensed-mercury temperature above the ambient temperature will not bring the condensed-mercury temperature up to the minimum value of the operating ranges specified under *Maximum Ratings*, some form of heat-conserving enclosure or auxiliary heater will be required.

Cooling—When the operating conditions are such that the maximum value of the operating condensed-mercury-temperature range is exceeded, provision should be made for forced-air cooling sufficient to prevent exceeding the maximum value.

Temperature Rise of Condensed Mercury to Equilibrium Above Ambient Temperature (Approx.):

No load	22	°C
Full load	26	°C

← Indicates a change.

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HALF-WAVE MERCURY-VAPOR RECTIFIER

HALF-WAVE RECTIFIER

Maximum Ratings, *Absolute Values: For supply frequency of 60 cps*

	Operating Condensed-Mercury-Temperature Range 20° to 60° C	
PEAK INVERSE ANODE VOLTAGE	7500 max.	volts
ANODE CURRENT:		
Peak	500 max.	ma
Average#	125 max.	ma
→ Fault, for duration of 0.1 second maximum	5 max.	amp

Averaged over any interval of 30 seconds maximum.

OPERATING CONSIDERATIONS

Shields and rf filter circuits should be provided for the 816 if it is subjected to extraneous high-frequency fields during operation. These fields tend to produce breakdown effects in mercury vapor and are detrimental to tube life and performance. When shields are used, special attention must be given to providing adequate ventilation and to maintaining normal condensed-mercury temperature. Rf filters are employed to prevent damage caused by rf currents which might otherwise be fed back into the rectifier tubes.

→ Indicates a change.

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HALF-WAVE MERCURY-VAPOR RECTIFIER

For Circuit Figures, see Front of this Section

CIRCUIT	MAX. TRANS. SEC. VOLTS (RMS) E	APPROX. DC OUTPUT VOLTS TO FILTER E_{av}	MAX. DC OUTPUT AMPERES I_{av}	MAX. DC OUTPUT KW TO FILTER P_{dc}
Fig. 1 Half-Wave Single-Phase In-Phase Operation	5300□	2400	0.125	0.3
Fig. 2 Full-Wave Single-Phase In-Phase Operation	2600□	2400	0.25	0.6
Fig. 3 Series Single-Phase In-Phase Operation	5300□	4800	0.25	1.2
Fig. 4 Half-Wave Three-Phase In-Phase Operation	3000□	3600	0.75	2.7
Fig. 5 Parallel Three-Phase Quadrature Operation	3000□	3600	1.5	5.4
Fig. 6 Series Three-Phase Quadrature Operation	3000□	7200	0.75	5.4
Fig. 7 Half-Wave Four-Phase Quadrature Operation	2600□	3500	*Resistive Load* 0.45 *Inductive Load* 0.5	*Resistive Load* 1.55 *Inductive Load* 1.75
Fig. 8 Half-Wave Six-Phase Quadrature Operation	2600□	3600	*Resistive Load* 0.47 *Inductive Load* 0.5	*Resistive Load* 1.7 *Inductive Load* 1.8

□ For maximum peak inverse anode voltage of 7500 volts and condensed-mercury-temperature range of 20° to 60° C.

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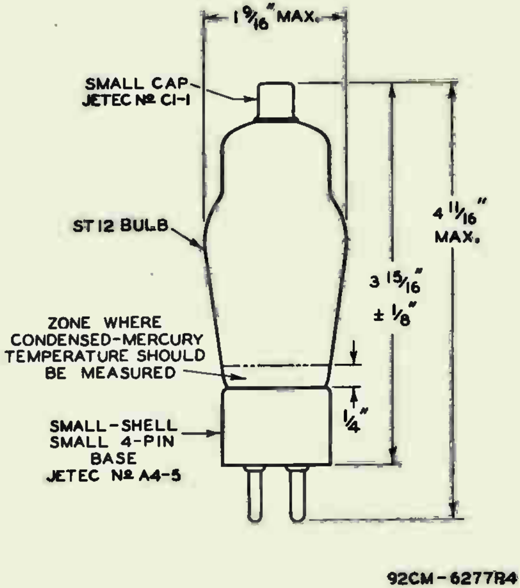
HALF-WAVE MERCURY-VAPOR RECTIFIER



ELECTRON TUBE DIVISION
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Power Triode

THORIATED-TUNGSTEN FILAMENT
ZIRCONIUM-COATED ANODE
RUGGED STRUCTURE
POST TERMINALS

1250 WATTS CW INPUT (CCS) TO 30 Mc WITH NATURAL COOLING
1800 WATTS CW INPUT (CCS) TO 20 Mc WITH FORCED-AIR COOLING

GENERAL DATA

Electrical:

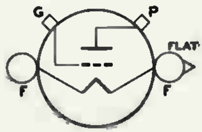
Filament, Thoriated Tungsten:		
Voltage (AC or DC)	10 ± 5%	volts
Current at heater volts = 10	10	amp
Amplification Factor, for grid volts = −10 and plate ma. = 200	35	
Direct Interelectrode Capacitances:		
Grid to plate	6.3	μμf
Grid to filament	12.3	μμf
Plate to filament	8.5	μμf

Mechanical:

Operating Position . . . . . . Vertical, with filament posts up or down; Horizontal, with plane of electrodes vertical (on edge) ←
Overall Length . . . . 8-5/8" ± 3/16"
Maximum Diameter . . . . 4-19/32"
Bulb T36
Weight (Approx.) . . . . 1 lb
Terminal Connections (See *Dimensional Outline*):

F – Filament

G – Grid



P – Plate

Thermal:

Cooling:

Natural or *forced air*—depending on the operating conditions. *Natural Cooling* means that adequate free circulation of air around the tube is necessary. *Forced-Air Cooling* means that an air flow of 40 cfm from a 2"-diameter nozzle directed vertically on bulb between grid and plate seals is required to limit temperature between these seals to 145° C.

Fittings: ←

Johnson (E.F. Johnson Company, Waseca, Minn.) Assembly Cat. No.124-212 consisting of ceramic mounting for filament end and two heat-radiating connectors for grid and plate terminals.

•,••,*: See next page. ← indicates a change.

AF POWER AMPLIFIER & MODULATOR — Class B

NATURAL COOLING

Maximum Ratings, *Absolute-Maximum Values:*

	CCS●	ICAS●●	
DC PLATE VOLTAGE	3000 max.	3300 max.	volts
MAX.-SIGNAL DC PLATE CURRENT*	500 max.	500 max.	ma
MAX.-SIGNAL PLATE INPUT*	1125 max.	1300 max.	watts
PLATE DISSIPATION*	300 max.	350 max.	watts

Typical Operation with Natural Cooling:

Values are for 2 tubes

	CCS●	ICAS●●	
DC Plate Voltage	3000	3300	volts
DC Grid Voltage#	-70	-80	volts
Peak AF Grid-to-Grid Voltage	400	440	volts
Zero-Signal DC Plate Current	100	100	ma
Max.-Signal DC Plate Current	750	780	ma
Effective Load Resistance (Plate to plate)	9500	10500	ohms
Max.-Signal Driving Power (Approx.)	20	30	watts
Max.-Signal Power Output (Approx.)	1650	1900	watts

FORCED-AIR COOLING

Maximum Ratings, *Absolute-Maximum Values:*

	CCS●	ICAS●●	
DC PLATE VOLTAGE	4000 max.	4000 max.	volts
MAX.-SIGNAL DC PLATE CURRENT*	500 max.	500 max.	ma
MAX.-SIGNAL PLATE INPUT*	1600 max.	1800 max.	watts
PLATE DISSIPATION*	400 max.	450 max.	watts

Typical Operation with Forced-Air Cooling:

Values are for 2 tubes

	CCS●	ICAS●●	
DC Plate Voltage	4000	4000	volts
DC Grid Voltage#	-100	-100	volts
Peak AF Grid-to-Grid Voltage	480	510	volts
Zero-Signal DC Plate Current	100	100	ma
Max.-Signal DC Plate Current	800	900	ma
Effective Load Resistance (Plate to plate)	12000	11000	ohms
Max.-Signal Driving Power (Approx.)	29	38	watts
Max.-Signal Power Output (Approx.)	2400	2700	watts

* Averaged over any audio-frequency cycle of sine-wave form.

●,●●,#: See next page.

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POWER TRIODE

RF POWER AMPLIFIER - Class B Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

NATURAL COOLING

	CCS●	ICAS●●	
Maximum Ratings, *Absolute Values:*			
DC PLATE VOLTAGE.	3000 max.	3300 max.	volts
DC PLATE CURRENT.	300 max.	300 max.	ma
PLATE INPUT	450 max.	525 max.	watts
PLATE DISSIPATION	300 max.	350 max.	watts
Typical Operation with Natural Cooling:			
DC Plate Voltage.	3000	3300	volts
DC Grid Voltage#.	-70	-100	volts
Peak RF Grid Voltage. . . .	90	110	volts
DC Plate Current.	150	150	ma
DC Grid Current (Approx.) .	2	2	ma
Driving Power (Approx.)▲. .	10	11	watts
Power Output (Approx.). . .	150	200	watts

FORCED-AIR COOLING

	CCS●	ICAS●●	
Maximum Ratings, *Absolute Values:*			
DC PLATE VOLTAGE.	4000 max.	4000 max.	volts
DC PLATE CURRENT.	300 max.	300 max.	ma
PLATE INPUT	600 max.	675 max.	watts
PLATE DISSIPATION	400 max.	450 max.	watts
Typical Operation with Forced-Air Cooling:			
DC Plate Voltage.	4000	4000	volts
DC Grid Voltage#.	-120	-120	volts
Peak RF Grid Voltage. . . .	120	130	volts
DC Plate Current.	150	150	ma
DC Grid Current (Approx.) .	2	3	ma
Driving Power (Approx.)▲. .	14	21	watts
Power Output (Approx.). . .	225	250	watts

PLATE-MODULATED RF POWER AMPLIFIER - Class C Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

NATURAL COOLING

	CCS●	ICAS●●	
Maximum Ratings, *Absolute Values:*			
DC PLATE VOLTAGE.	2500 max.	3000 max.	volts
DC GRID VOLTAGE	-500 max.	-500 max.	volts
DC PLATE CURRENT.	400 max.	400 max.	ma

For ac filament supply.

▲ At crest of audio-frequency cycle with modulation factor of 1.0.

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	CCS●	ICAS●●	
DC GRID CURRENT	100 max.	100 max.	ma
PLATE INPUT	835 max.	1000 max.	watts
PLATE DISSIPATION	200 max.	250 max.	watts

Typical Operation with Natural Cooling:

DC Plate Voltage	2500	3000	volts
DC Grid Voltage●	-300	-240	volts
From a grid resistor of	4000	3400	ohms
Peak RF Grid Voltage	460	410	volts
DC Plate Current	335	335	ma
DC Grid Current (Approx.)●	75	70	ma
Driving Power (Approx.)●	30	26	watts
Power Output (Approx.)	635	800	watts

FORCED-AIR COOLING

Maximum Ratings, *Absolute Values:*

	CCS●	ICAS●●	
DC PLATE VOLTAGE	3000 max.	4000 max.	volts
DC GRID VOLTAGE	-500 max.	-500 max.	volts
DC PLATE CURRENT	450 max.	450 max.	ma
DC GRID CURRENT	100 max.	100 max.	ma
PLATE INPUT	1250 max.	1800 max.	watts
PLATE DISSIPATION	270 max.	350 max.	watts

Typical Operation with Forced-Air Cooling:

DC Plate Voltage	3000	4000	volts
DC Grid Voltage●	-300	-325	volts
From a grid resistor of	3600	3600	ohms
Peak RF Grid Voltage	490	520	volts
DC Plate Current	415	450	ma
DC Grid Current (Approx.)●	85	90	ma
Driving Power (Approx.)●	37	42	watts
Power Output (Approx.)	1000	1500	watts

RF POWER AMPLIFIER & OSCILLATOR--Class C Telegraphy□□
and
RF POWER AMPLIFIER--Class C FM Telephony

NATURAL COOLING

Maximum Ratings, *Absolute Values:*

	CCS●	ICAS●●	
DC PLATE VOLTAGE	3000 max.	3300 max.	volts
DC GRID VOLTAGE	-500 max.	-500 max.	volts
DC PLATE CURRENT	500 max.	500 max.	ma

● Obtained by grid resistor, or from a combination of grid resistor with either fixed supply or cathode resistor.

□□ Key-down conditions per tube without amplitude modulation. Amplitude modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

●, ●●, ⊕: See next page.

RCA

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POWER TRIODE

	CCS●	ICAS●●	
DC GRID CURRENT	100 max.	100 max.	ma
PLATE INPUT	1250 max.	1500 max.	watts
PLATE DISSIPATION	300 max.	350 max.	watts

Typical Operation with Natural Cooling: ←

	CCS	CCS	ICAS	ICAS	
DC Plate Voltage.	2250	3000	3000	3000	volts
DC Grid Voltage	–125	–200	–160	–155	volts
From a grid resistor of	1500	3600	2300	2150	ohms
From a cathode resistor of	235	425	400	270	ohms
Peak RF Grid Voltage. . . .	300	360	310	350	volts
DC Plate Current.	445	415	335	500	ma
DC Grid Current (Approx.)●.	85	55	70	70	ma
Driving Power (Approx.)●.	23	20	20	25	watts
Power Output (Approx.)	780	1000	800	1150	watts

FORCED-AIR COOLING

Maximum Ratings, *Absolute Values:*

	CCS●	ICAS●●	
DC PLATE VOLTAGE.	4000 max.	4000 max.	volts
DC GRID VOLTAGE	–500 max.	–500 max.	volts
DC PLATE CURRENT.	500 max.	500 max.	ma
DC GRID CURRENT	100 max.	100 max.	ma
PLATE INPUT	1800 max.	2000 max.	watts
PLATE DISSIPATION	400 max.	450 max.	watts

Typical Operation with Forced-Air Cooling:

	CCS	ICAS	
DC Plate Voltage.	4000	4000	volts
DC Grid Voltage▲▲	–200	–225	volts
From a grid resistor of	2650	2400	ohms
From a cathode resistor of	380	380	ohms
Peak RF Grid Voltage. . . .	375	415	volts
DC Plate Current.	450	500	ma
DC Grid Current●.	75	95	ma
Driving Power (Approx.)●. .	26	35	watts
Power Output (Approx.). . .	1440	1600	watts

● Subject to wide variation depending on the impedance of the load circuit. High-impedance load circuits require more grid current and driving power to obtain the desired output. Low-impedance load circuits need less grid current and driving power, but plate-circuit efficiency is sacrificed. The driver stage should have good regulation and should be capable of delivering considerably more than the required driving power.

▲▲ Obtained from fixed supply, by grid resistor, by cathode resistor, or by combination methods.

●, ●●: See next page. ← Indicates a change.

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833-A

833-A

POWER TRIODE

NOTE: When the 833-A is used in the final amplifier or a preceding stage of a transmitter designed for break-in operation and oscillator keying, a small amount of fixed-bias must be used to maintain the plate current at a safe value. With a plate voltage of 4000 volts, a fixed bias of at least -90 volts should be used.

SELF-RECTIFYING OSCILLATOR OR AMPLIFIER - Class C

NATURAL COOLING

	CCS●	*ICAS*●●	
Maximum Ratings, *Absolute Values:*			
AC PLATE VOLTAGE (RMS) . . .	4250 max.	4650 max.	volts
DC GRID VOLTAGE	-315 max.	-315 max.	volts
DC PLATE CURRENT.	250 max.	250 max.	ma
DC GRID CURRENT	50 max.	50 max.	ma
PLATE INPUT**	1180 max.	1290 max.	watts
PLATE DISSIPATION	300 max.	350 max.	watts
Typical Operation with Natural Cooling:			
AC Plate Voltage (RMS). . .	4000	4400	volts
DC Grid Voltage↓.	-80	-85	volts
From a grid resistor of	2200	2400	ohms
DC Plate Current.	240	240	ma
DC Grid Current (Approx.) .	37	36	ma
Driving Power (Approx.)## .	13	13.5	watts
Output-Circuit Efficiency (Approx.). . . .	85	85	%
Useful Power Output (Approx.)	710°	800°	watts

FORCED-AIR COOLING

	CCS●	
Maximum Ratings, *Absolute Values:*		
AC PLATE VOLTAGE (RMS).	5650 max.	volts
DC GRID VOLTAGE	-315 max.	volts
DC PLATE CURRENT.	250 max.	ma
DC GRID CURRENT	50 max.	ma
PLATE INPUT	1570 max.	watts
PLATE DISSIPATION	400 max.	watts
Typical Operation with Forced-Air Cooling:		
AC Plate Voltage (RMS).	5300	volts
DC Grid Voltage↓.	-97	volts
From a grid resistor of	2700	ohms
DC Plate Current.	240	ma
DC Grid Current (Approx.)	35	ma
Driving Power (Approx.)##	14	watts
Output-Circuit Efficiency (Approx.) . . .	85	%
Useful Power Output (Approx.)	975°	watts

** Power input to plate is 1.11 times the product of ac plate voltage (rms) and the dc plate current.

From a self-rectified driver.

●, ●●, ↓, °: See next page.

→ Indicates a change.

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