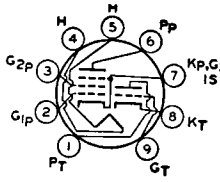
Refer to chart at end of section.
For replacement use type 6EM7/6EA7.

6EA7



9AE

MEDIUM-MU TRIODE—SHARP-CUTOFF PENTODE

6EA8

5EA8, 19EA8

Miniature type used as combined oscillator and mixer in color and black-and-white television receivers utilizing an intermediate frequency in the order of 40 MHz. **Outlines section,** 6B; requires miniature 9-contact socket. Types 5EA8 and 19EA8 are identical with type 6EA8 except for heater ratings.

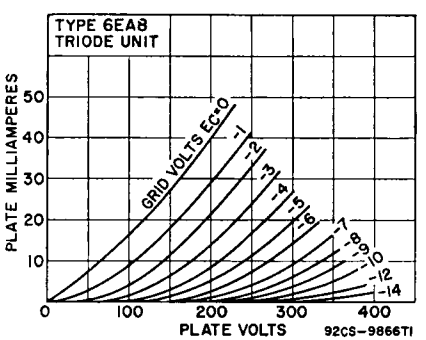
	5EA8	6EA8	19EA8	
Heater Voltage (ac/dc)	4.7	6.3	18.9	volts
Heater Current	0.6	0.45	0.15	ampere
Heater Warm-up Time (Average)	11	11	11	seconds
Heater-Cathode Voltage:				
Peak value	±200 max	±200 max	±200 max	volts
Average value	100 max	100 max	100 max	volts

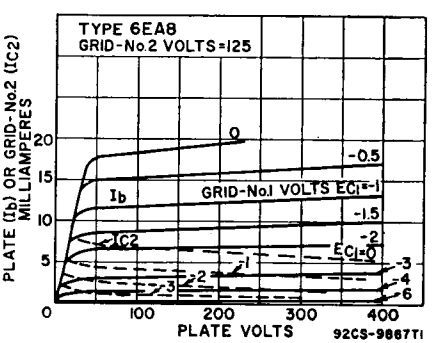
	Unshielded	Shielded	
Direct Interelectrode Capacitances:			
Triode Unit:			
Grid to Plate	1.7	1.7	pF
Grid to Cathode, Heater, Pentode Cathode, Pentode Grid No.3, and Internal Shield	3	3.2	pF
Plate to Cathode, Heater, Pentode Cathode, Pentode Grid No.3, and Internal Shield	1.4	1.9	pF
Cathode to Heater	3	3▪	pF
Pentode Unit:			
Grid No.1 to Plate	0.02 max	0.01 max	pF
Grid No.1 to Cathode, Heater, Grid No.2, Grid No.3, and Internal Shield	5	5	pF
Plate to Cathode, Heater, Grid No.2, Grid No.3, and Internal Shield	2.6	3.4	pF
Heater to Cathode	3	3▪	pF

° With external shield connected to cathode of unit under test except as noted.
▪ With external shield connected to ground.

Class A_1 Amplifier

MAXIMUM RATINGS (Design-Maximum Values)	Triode Unit	Pentode Unit	
Plate Voltage	330	330	volts
Grid-No.2 (Screen-Grid) Supply Voltage	—	330	volts
Grid-No.2 Voltage	—	See curve page 300	
Grid-No.1 (Control-Grid) Voltage, Positive-bias value	0	0	volts
Plate Dissipation	2.5	3.1	watts
Grid-No.2 Input:			
For grid-No.2 voltages up to 165 volts	—	0.55	watt
For grid-No.2 voltages between 165 and 330 volts	—	See curve page 300	



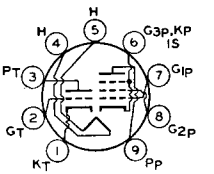


CHARACTERISTICS

Plate Supply Voltage	150	125	volts
Grid-No.2 Voltage	—	125	volts
Grid-No.1 Voltage	—	—1	volt
Cathode-Bias Resistor	56	—	ohms
Amplification Factor	40	—	
Plate Resistance (Approx.)	5000	200000	ohms
Transconductance	8500	6400	μmhos
Plate Current	18	12	mA
Grid-No.2 Current	—	4	mA
Grid-No.1 Voltage for plate current of 10 μA	—12	—9	volts

6EB8 HIGH-MU TRIODE—SHARP-CUTOFF PENTODE

Miniature type used in color and black-and-white television receiver applications. Pentode unit is used as video output amplifier; triode unit is used in sync-separator, sync-clipper, and phase-inverter circuits. **Outlines** section, 6E; requires miniature 9-contact socket.



9DX

Heater Voltage (ac/dc)	6.3	volts
Heater Current	0.75	ampere
Heater-Cathode Voltage:		
Peak value	±200 max	volts
Average value	100 max	volts
Direct Interelectrode Capacitances:		
Triode Unit:		
Grid to Plate	4.4	pF
Grid to Cathode and Heater	2.4	pF
Plate to Cathode and Heater	0.36	pF
Pentode Unit:		
Grid No.1 to Plate	0.1 max	pF
Grid No.1 to Cathode, Heater, Grid No.2, Grid No.3, and Internal Shield	11	pF
Plate to Cathode, Heater, Grid No.2, Grid No.3, and Internal Shield	4.2	pF
Triode Grid to Pentode Plate	0.018 max	pF
Pentode Grid No.1 to Triode Plate	0.005 max	pF
Pentode Plate to Triode Plate	0.17 max	pF

Class A_1 Amplifier

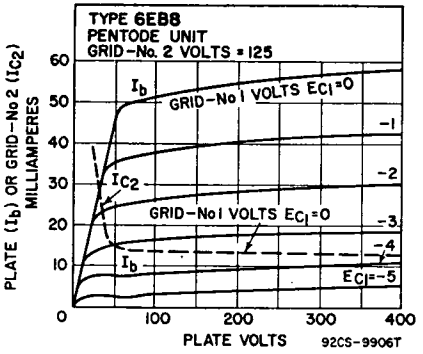
MAXIMUM RATINGS (Design-Maximum Values)	Triode Unit	Pentode Unit	
Plate Voltage	330	330	volts
Grid-No.2 (Screen-Grid) Supply Voltage	—	330	volts
Grid-No.2 Voltage	—	See curve page 300	
Grid-No.1 (Control-Grid) Voltage, Positive-bias value	0	0	volts
Plate Dissipation	1	5	watts
Grid-No.2 Input:			
For grid-No.2 voltages up to 165 volts	—	1.1	watts
For grid-No.2 voltages between 165 and 330 volts	—	See curve page 300	

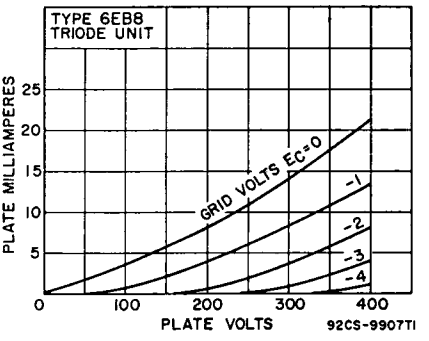
CHARACTERISTICS

Plate Supply Voltage	250	200	volts
Grid-No.2 Supply Voltage	—	125	volts
Grid Voltage	—2	—	volts
Cathode-Bias Resistor	—	68	ohms
Amplification Factor	100	—	
Plate Resistance (Approx.)	37000	75000	ohms
Transconductance	2700	12500	μmhos
Plate Current	2	25	mA
Grid-No.2 Current	—	7	mA
Grid Voltage (Approx.) for plate current of 20 μA	—5	—	volts
Grid-No.1 Voltage (Approx.) for plate current of 100 μA	—	—9	volts

MAXIMUM CIRCUIT VALUES

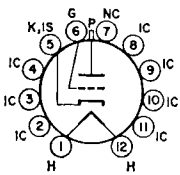
Grid-No.1-Circuit Resistance:			
For fixed-bias operation	0.5	0.25	megohm
For cathode-bias operation	1	1	megohm





Refer to chart at end of section. **6EC4A/EY500**

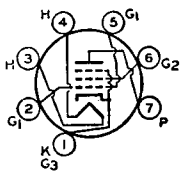
Refer to chart at end of section. For replacement use type 6EH4A. **6EH4**



BEAM TRIODE

6EH4A

Duodecar type used as a shunt regulator in the high-voltage power supply of color television receivers. **Outlines section,** 16G; requires duodecar 12-contact socket. For high-voltage and X-ray safety considerations, refer to page 93. This type is electrically identical with type 6EJ4A.



POWER PENTODE

6EH5

25EH5, 50EH5

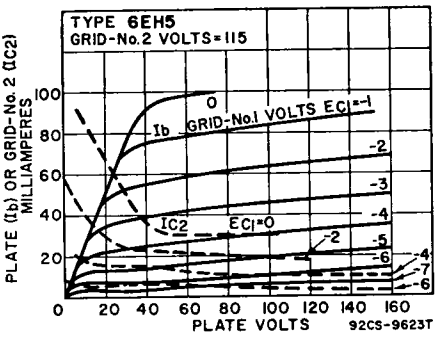
Miniature type used in the audio output stage of radio and television receivers and in phonographs. **Outlines section,** 5D; requires miniature 7-contact socket. Types 25EH5 and 50EH5 are identical with type 6EH5 except for heater ratings.

	6EH5	25EH5	50EH5	
Heater Voltage (ac/dc)	6.3	25	50	volts
Heater Current	1.2	0.3	0.15	ampere
Heater-Cathode Voltage:				
Peak value	±200 max	±200 max	±200 max	volts
Average value	100 max	100 max	100 max	volts
Direct Interelectrode Capacitances (Approx.):				
Grid No.1 to Plate			0.65	pF
Grid No.1 to Cathode, Heater, Grid No.2, and Grid No.3			17	pF
Plate to Cathode, Heater, Grid No.2, and Grid No.3			9	pF

Class A_1 Amplifier

MAXIMUM RATINGS (Design-Maximum Values)		
Plate Voltage	150	volts
Grid-No.2 (Screen-Grid) Voltage	130	volts
Plate Dissipation	5.5	watts
Grid-No.2 Input	2	watts
Bulb Temperature (At hottest point)	220	°C
TYPICAL OPERATION		
Plate Supply Voltage	110	volts
Grid-No.2 Supply Voltage	115	volts
Cathode-Bias Resistor	62	ohms
Peak AF Grid-No.1 Voltage	3	volts

Zero-Signal Plate Current	42	mA
Maximum-Signal Plate Current	42	mA
Zero-Signal Grid-No.2 Current	11.5	mA
Maximum-Signal Grid-No.2 Current	14.5	mA
Plate Resistance (Approx.)	11000	ohms
Transconductance	14600	μmhos
Load Resistance	3000	ohms
Total Harmonic Distortion	7	per cent
Maximum-Signal Power Output	1.4	watts



MAXIMUM CIRCUIT VALUES

Grid-No.1-Circuit Resistance:		
For fixed-bias operation	0.1	megohm
For cathode-bias operation	0.5	megohm

Push-Pull Class AB$_1$ Audio-Frequency Power Amplifier

MAXIMUM RATINGS (Same as for Class A$_1$ audio-frequency power amplifier)

TYPICAL OPERATION (Values are for two tubes)

Plate Supply Voltage	140	volts
Grid-No.2 Supply Voltage	120	volts
Cathode-Bias Resistor	68	ohms
Peak AF Grid-No.1 Voltage	9.4	volts
Zero-Signal Plate Current	47	mA
Maximum-Signal Plate Current	51	mA
Zero-Signal Grid-No.2 Current	11	mA
Maximum-Signal Grid-No.2 Current	17.7	mA
Effective Load Resistance (Plate-to-plate)	6000	ohms
Total Harmonic Distortion	5	per cent
Maximum-Signal Power Output	3.8	watts

MAXIMUM CIRCUIT VALUES

Grid-No.1-Circuit Resistance:		
For fixed-bias operation	0.1	megohm
For cathode-bias operation	0.5	megohm

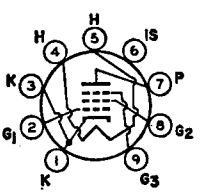
6EH7

Refer to chart at end of section.
For replacement use type 6EH7/EF183.

6EH7/ EF183

3EH7/XF183, 4EH7/LF183

SEMIREMOTE-CUTOFF PENTODE



9AQ

Miniature types used as if-amplifier tubes in color and black-and-white television receivers. **Outlines section,** 6C; requires miniature 9-contact socket. Types 3EH7/XF183 and 4EH7/LF183 are identical with type 6EH7/EF183 except for heater ratings.

	3EH7/ XF183	4EH7/ LF183	6EH7/ EF183	
Heater Voltage (ac/dc)	3.4	4.4	6.3	volts
Heater Current	0.6	0.45	0.3	ampere
Peak Heater-Cathode Voltage	±150 max	±150 max	±150 max	volts
Direct Interelectrode Capacitances:				
Grid No.1 to Plate			0.005 max	pF
Grid No.1 to Cathode, Heater, Grid No.2, Grid No.3, and Internal Shield			9	pF
Plate to Cathode, Heater, Grid No.2, Grid No.3, and Internal Shield			3	pF

Class A_1 Amplifier

MAXIMUM RATINGS (Design-Center Values)

Plate Supply Voltage	550	volts
Plate Voltage	250	volts
Grid-No.3 (Suppressor-Grid) Voltage, Positive value	0	volts
Grid-No.2 (Screen-Grid) Supply Voltage	550	volts
Grid-No.2 Voltage	250	volts
Cathode Current	20	mA
Plate Dissipation	2.5	watts
Grid-No.2 Input	0.65	watt

CHARACTERISTICS

Plate Voltage	200	volts
Grid No.3	Connected to cathode at socket	
Grid-No.2 Voltage	90	volts
Grid-No.1 Voltage	—2	volts
Plate Resistance (Approx.)	0.5	megohm
Transconductance	12500	μmhos
Plate Current	12	mA
Grid-No.2 Current	4.5	mA

TYPICAL OPERATION

Plate Voltage	200	200	200	200	volts
Grid No.3	Connected to cathode at socket				
Grid-No.2 Supply Voltage	200	200	200	200	volts
Grid-No.2 Series Resistor	22000	22000	22000	22000	ohms
Grid-No.1 Voltage	—19.5	—9.5	—6.5	—2	volts
Transconductance	125	625	1250	12500	μmhos
RMS Grid-No.1 Voltage, for cross-modulation factor of 0.01	450	160	100	—	mV

MAXIMUM CIRCUIT VALUE

Grid-No.1-Circuit Resistance	1	megohm

Refer to chart at end of section. **6EH8**

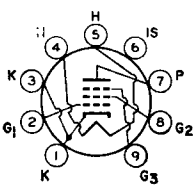
Refer to chart at end of section. **6EJ4A**

Refer to chart at end of section. **6EJ7**
For replacement use type 6EJ7/EF184.

6EJ7/ EF184

3EJ7/XF184, 4EJ7/LF184

SHARP-CUTOFF PENTODE



9AQ

Miniature types used as if-amplifier tubes in color and black-and-white television receivers. **Outlines section,** 6C; requires miniature 9-contact socket. Types 3EJ7/XF184 and 4EJ7/LF184 are identical with type 6EJ7/EF184 except for heater ratings.

	3EJ7/ XF184	4EJ7/ LF184	6EJ7/ EF184	
Heater Voltage (ac/dc)	3.4	4.4	6.3	volts
Heater Current	0.6	0.45	0.3	ampere
Peak Heater-Cathode Voltage	±150 max	±150 max	±150 max	volts

Direct Interelectrode Capacitances:		
Grid No.1 to Plate	0.005 max	pF
Grid No.1 to Cathode, Heater, Grid No.2, Grid No.3, and Internal Shield	10	pF
Plate to Cathode, Heater, Grid No.2, Grid No.3, and Internal Shield	3	pF

Class A_1 Amplifier

MAXIMUM RATINGS (Design-Center Values)

Plate Supply Voltage	550	volts
Plate Voltage	250	volts
Grid-No.2 (Screen-Grid) Supply Voltage	550	volts
Grid-No.2 Voltage	250	volts
Cathode Current	25	mA
Plate Dissipation	2.5	watts
Grid-No.2 Input	0.9	watt

CHARACTERISTICS

Plate Voltage	190	200	volts
Grid No.3	Connected to cathode at socket		
Grid-No.2 Voltage	190	200	volts
Grid-No.1 Voltage	—2.35	—2.5	volts
Plate Resistance (Approx.)	0.35	0.35	megohm
Transconductance	15000	15000	μmhos
Plate Current	10	10	mA
Grid-No.2 Current	4.1	4.1	mA

MAXIMUM CIRCUIT VALUE

Grid-No.1-Circuit Resistance	1	megohm

6EL4
6EL4A

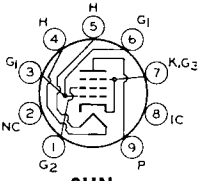
Refer to chart at end of section.
For replacement use type 6BK4C/6EL4A.

6EM5

8EM5

BEAM POWER TUBE

Miniature type used as vertical-deflection amplifier in television receivers utilizing picture tubes having diagonal deflection angles of 110 degrees. **Outlines section,** 6G; requires miniature 9-contact socket. Type 8EM5 is identical with type 6EM5 except for heater ratings.



9HN

	6EM5	8EM5	
Heater Voltage (ac/dc)	6.3	8.4	volts
Heater Current	0.8	0.6	ampere
Heater Warm-up Time (Average)	—	11	seconds
Heater-Cathode Voltage:			
Peak value	±200 max	±200 max	volts
Average value	100 max	100 max	volts
Direct Interelectrode Capacitances:			
Grid No.1 to Plate		0.7 max	pF
Grid No.1 to Cathode, Heater, Grid No.2, and Grid No.3		10	pF
Plate to Cathode, Heater, Grid No.2, and Grid No.3		5.1	pF

Class A_1 Amplifier

CHARACTERISTICS

Plate Voltage	60	250	volts
Grid-No.2 Voltage	250	250	volts
Grid-No.1 Voltage	0	—18	volts
Mu Factor, Grid No.1 to Grid No.2	—	8.7	
Plate Resistance	—	0.05	megohm
Transconductance	—	5100	μmhos
Plate Current	180•	40	mA
Grid-No.2 Current	30•	3	mA
Grid-No.1 Voltage (Approx.) for plate current of 0.2 mA	—	—37	volts

• These values can be measured by a method involving a recurrent waveform such that the maximum ratings of the tube will not be exceeded.

Vertical-Deflection Oscillator and Amplifier

For operation in a 525-line, 30-frame system

MAXIMUM RATINGS (Design-Center Values)

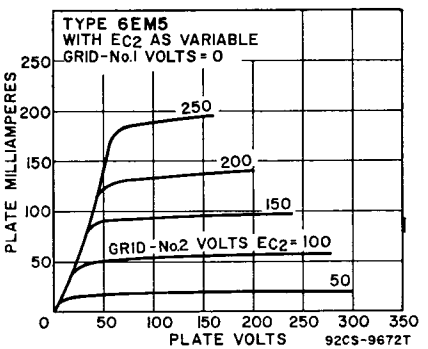
DC Plate Voltage	315	volts
Peak Positive-Pulse Plate Voltage# (Absolute Maximum)	2200▲	volts
Grid-No.2 (Screen-Grid) Voltage	285	volts
Peak Negative-Pulse Grid-No.1 (Control-Grid) Voltage	250	volts
Peak Cathode Current	210	mA
Average Cathode Current	60	mA
Plate Dissipation	10	watts
Grid-No.2 Input	1.5	watts
Bulb Temperature (At hottest point)	250	°C

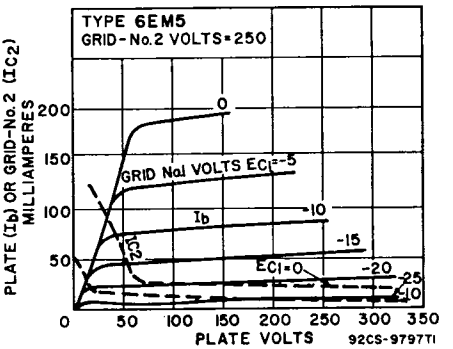
MAXIMUM CIRCUIT VALUE

Grid-No.1-Circuit Resistance	2.2	megohms

Pulse duration must not exceed 15% of a vertical scanning cycle (2.5 milliseconds).

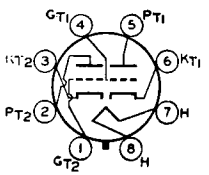
▲ Under no circumstances should this absolute value be exceeded.





Refer to chart at end of section. **6EM7**

For replacement use type 6EM7/6EA7.



8BD

6EM7/6EA7

10EM7, 13EM7/15EA7

DUAL TRIODE

Glass octal type used as combined vertical-deflection amplifier and vertical-deflection oscillator in color and black-and-white television receivers. **Outlines section,** 13A; requires octal socket. For curve of average plate characteristics, Unit No.1, refer to type 6DR7 (Unit No.1). Types 10EM7, and 13EM7/15EA7 are identical with type 6EM7/6EA7 except for heater ratings.

	6EM7/6EA7	10EM7	13EM7/15EA7	
Heater Voltage (ac/dc)	6.3	9.7	13	volts
Heater Current	0.925	0.6	0.45	ampere
Heater Warm-up Time (Average)	—	11	11	seconds
Heater-Cathode Voltage:				
Peak value	±200 max	±200 max	±200 max	volts
Average value	100 max	100 max	100 max	volts
Direct Interelectrode Capacitances (Approx.):	Unit No.1	Unit No.2		
Grid to Plate	4.8	10		pF
Grid to Cathode and Heater	2.2	7		pF
Plate to Cathode and Heater	0.6	1.8		pF

Class A_1 Amplifier

CHARACTERISTICS	Unit No.1	Unit No.2	
Plate Voltage	250	150	volts
Grid Voltage	—3	—20	volts
Amplification Factor	64	5.4	
Plate Resistance (Approx.)	40000	750	ohms
Transconductance	1600	7200	μmhos
Plate Current	1.4	50	mA
Plate Current, for plate voltage of 60 volts and zero grid voltage	—	95	mA
Plate Current, for grid voltage of —28 volts	—	10	mA
Grid Voltage (Approx.):			
For plate current of 10 μA	—5.5	—	volts
For plate current of 100 μA	—	—45	volts

Vertical-Deflection Oscillator and Amplifier

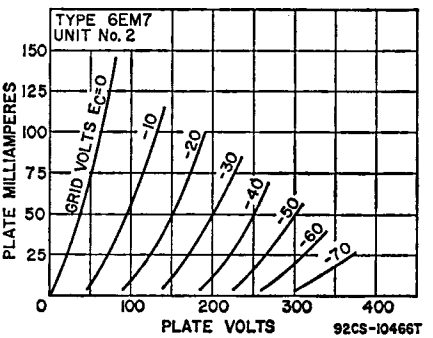
For operation in a 525-line, 30-frame system

MAXIMUM RATINGS (Design-Maximum Values)	Unit No.1 Oscillator	Unit No.2 Amplifier	
DC Plate Voltage	330	330	volts
Peak Positive-Pulse Plate Voltage#	—	1500	volts
Peak Negative-Pulse Grid Voltage	400	250	volts
Peak Cathode Current	77	175	mA
Average Cathode Current	22	50	mA
Plate Dissipation	1.5	10	watts

MAXIMUM CIRCUIT VALUES

Grid-Circuit Resistance:	Unit No.1	Unit No.2	
For grid-resistor-bias operation	2.2	2.2	megohms
For cathode-bias operation	2.2	2.2	megohms

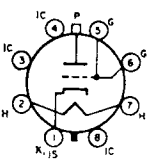
Pulse duration must not exceed 15% of a vertical scanning cycle (2.5 milliseconds).



6EN4

SHARP-CUTOFF BEAM TRIODE

Glass octal type used as a shunt voltage-regulator tube in the high-voltage power supply of color television receivers. **Outlines section,** 21B; requires octal socket. Socket terminals 3, 4, and 8 should not be used as tie points. For high voltage and X-ray safety considerations, refer to page 93.



8NJ

Heater Voltage (ac/dc)	6.3	volts
Heater Current	0.2	ampere
Peak Heater-Cathode Voltage	—450* max	volts
Direct Interelectrode Capacitances (Approx.):‡		
Grid to Plate	1	pF
Plate to Cathode and Heater	2.6	pF
Grid to Cathode and Heater	1	pF

* Series impedance should be used with the cathode to limit the cathode current under prolonged short-circuit conditions to 450 mA.

‡ Without external shield.

Shunt Voltage-Regulator Service

MAXIMUM RATINGS (Design-Maximum Values)

DC Plate Voltage	30000	volts
Unregulated DC Supply Voltage	60000	volts
DC Grid Voltage	—135	volts
Peak Grid Voltage■	—440	mA
Average Plate Current	1.6	mA
Plate Dissipation	40	watts

TYPICAL OPERATION

Unregulated DC Supply Voltage	36000	volts
Equivalent Resistance of Unregulated Supply	11	megohms
Voltage Divider Values:		
R_1 (5 watts)	220	megohms
R_2 (2 watts)	1	megohm
R_3 (0.5 watt)	0.82	megohm
DC Reference Voltage Supply	200	volts
Equivalent Resistance of Reference Voltage	1000	ohms
Effective Grid-Plate Transconductance	200	μmhos
DC Plate Current for Load Current of 0 mA	1000	μA
DC Plate Current for Load Current of 1 mA	45	μA
Regulated DC Output Voltage for Load Current of 0 mA	25000	volts
Regulated DC Output Voltage for Load Current of 1 mA	24500	volts
Amplification Factor	2000	

MAXIMUM CIRCUIT VALUE

Grid-Circuit Resistance	3	megohms

■ For interval of 20 seconds maximum during equipment warm-up period.

CHARACTERISTICS RANGE VALUES

	Note	Min	Max	
Grid Voltage (1)	1	—7	—	volts
Grid Voltage (2)	2	—	—40	volts
Grid-Voltage Change	3	—	9	volts

Note 1: With dc plate voltage of 30000 volts and dc plate current of 1 mA.

Note 2: With dc plate voltage of 30000 volts and dc plate current of 0.1 mA.

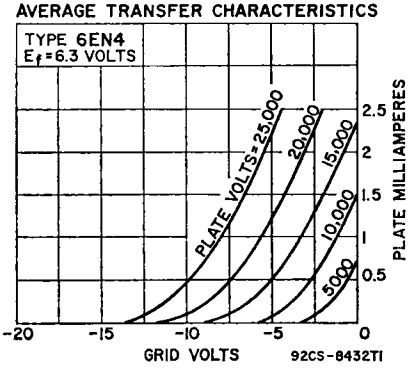
Note 3: Difference between grid voltage (1) and grid voltage (2).

X-RADIATION CHARACTERISTIC

X-Radiation, Maximum:		
Statistical value controlled on a lot sampling basis	0.5	mR/hr

Caution—Operation of this tube outside of the maximum values indicated above may result in either temporary or permanent changes in the X-radiation characteristic of the tube. Equipment design must be such that these maximum values are not exceeded.

AVERAGE TRANSFER CHARACTERISTICS



Refer to chart at end of section.