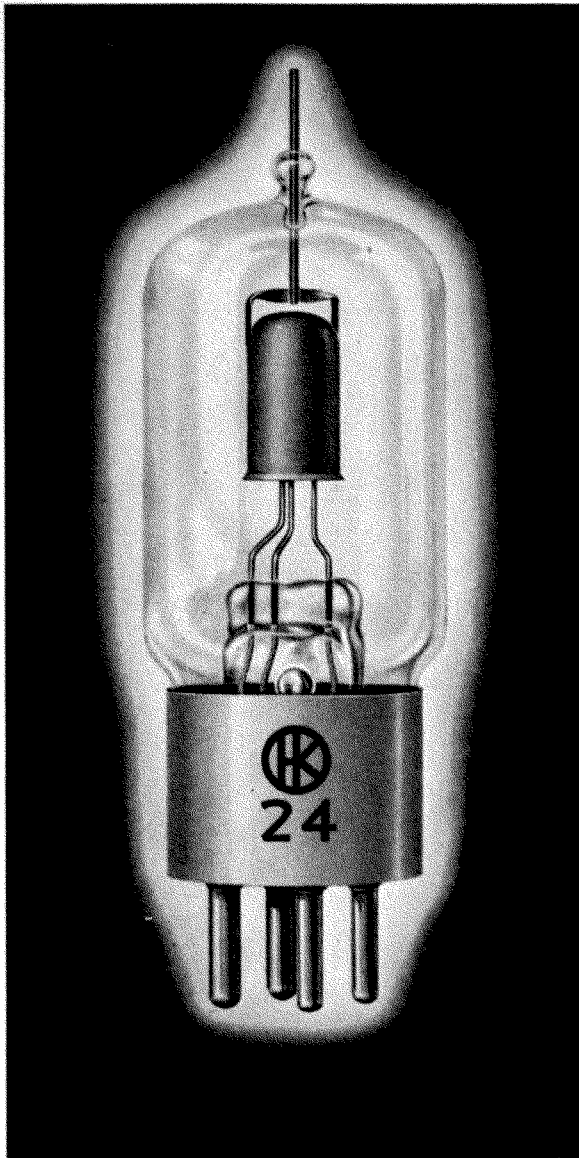


GAMMATRON TYPE 24



GENERAL PURPOSE TRIODE

Medium mu universal triode, 25 watt radiation cooled tantalum plate. Special design permits high voltage operation and unusual VHF efficiency.

PHYSICAL DATA

Plate	Cylindrical Tantalum
Grid	Braced Vertical Bar Tantalum
Filament	Thoriated Tungsten
Base	Small Four Pin Ceramic
Net Weight	1¼ Ounces
Shipping Weight	1¼ Pounds
Maximum Height	4¾ Inches
Maximum Diameter	1-7/16 Inches

ELECTRICAL DATA

Filament Voltage	6.3 Volts
Filament Current	3.0 Amps
Normal Plate Dissipation	25 Watts
Maximum Average Plate Current	75 MA.
Maximum Average Grid Current	25 MA.
Maximum Plate Voltage	2000 Volts
Average Amplification Constant	25

INTERELECTRODE CAPACITANCES

Grid-Plate	1.3 Mmfd.
Grid-Filament	2.1 Mmfd.
Plate-Filament	0.2 Mmfd.

The type 24 Gammatron is a tube of unusual capabilities. The use of a long capped tantalum plate helps to confine all of the electron stream for useful power output. Its uniquely designed tantalum grid is closely spaced to the filament providing short electron time flight thus reducing losses at very high frequencies. Internal insulators are not required while at the same time perfect alignment is maintained. Thus the interelectrode capacities are low enabling the tube to operate free of parasitic oscillations.

With the use of tantalum and the elimination of unnecessary internal structures, it is possible to completely outgas

Gammatron tubes without the use of the usual "getter." This excellent vacuum is retained throughout the full life of the tube, thus insuring you against failures caused by gas release due to overloads. The filament may then be operated in a manner consistent with high thermionic efficiency and long life.

The tantalum plate is designed to run hot. A cherry red color is an indication of normal operation and no damage will result at this temperature. The convenience of the use of the plate color as an indication of proper circuit efficiency and tuning will be appreciated immediately after trying the 24 GAMMATRON.

3500 8-45

HEINTZ AND KAUFMAN LTD.

SOUTH SAN FRANCISCO, CALIFORNIA, U. S. A

TYPE HK-24

The information on this page does not represent exact conditions of operation to be imposed for any particular situation. Because tubes are used under many widely different conditions, Heintz and Kaufman will gladly furnish information for applications which differ appreciably from the illustrative examples given.

RADIO FREQUENCY POWER AMPLIFIER— CLASS "C" UNMODULATED

	Maximum Rating Per Tube	Typical Operation, 1 Tube			
D.C. Plate Voltage	2000	2000	1500	1000	Volts
D.C. Plate Current	75	56	75	75	M. A.
D.C. Grid Current	20	18	18	18	M. A.
D.C. Grid Voltage	-250	-140	-120	-100	Volts
Peak R.F. Grid Voltage		250	240	220	Volts
Grid Driving Power		4.0	3.8	3.6	Watts
Plate Dissipation	25	25	25	18	Watts
Plate Efficiency		81	80	76	Percent
Power Output		90	90	57	Watts
Plate Input	112	Watts			

RADIO FREQUENCY POWER AMPLIFIER— CLASS "C" PLATE MODULATED

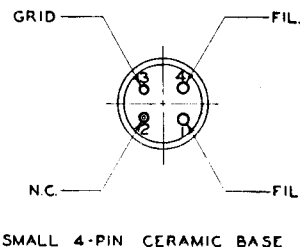
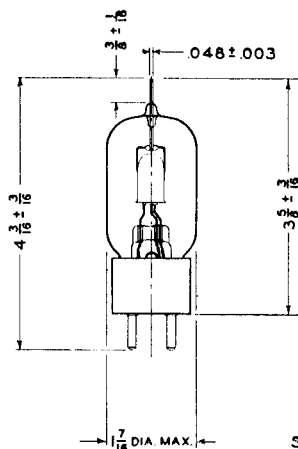
(Carrier Conditions for use with 100% Modulation)

	Maximum Rating Per Tube	Typical Operation, 1 Tube			
D.C. Plate Voltage	1500	1500	1250	1000	Volts
D.C. Plate Current	60	50	60	60	M. A.
D.C. Grid Current	20	20	20	20	M. A.
D.C. Grid Voltage	-250	-145	-125	-105	Volts
Peak R.F. Grid Voltage		245	230	210	Volts
Grid Driving Power		4.5	4.1	3.8	Watts
Plate Dissipation	17	15	15	13	Watts
Plate Efficiency		80	80	78	Percent
Power Output		60	60	47	Watts
Plate Input	75	Watts			

RADIO FREQUENCY DOUBLER AMPLIFIER

(Feedback Voltage Neutralized by
Conventional Methods)

	Maximum Rating Per Tube	Typical Operation, 1 Tube			
D.C. Plate Voltage	1500	1500	1250	1000	Volts
D.C. Plate Current	70	50	58	70	M. A.
D.C. Grid Voltage	-250	-240	-250	-250	Volts
D.C. Grid Current	18	12	14	18	M. A.
Peak R.F. Grid Voltage		345	365	380	Volts
Driving Power		3.9	4.7	6.4	Watts
Plate Dissipation	25	24	24	25	Watts
Tube Efficiency		68	67	64	Percent
Power Output		51	49	45	Watts



AUDIO FREQUENCY POWER AMPLIFIER— CLASS "B" MODULATOR

	Maximum Rating Per Tube	Typical Operation, 2 Tubes			
D.C. Plate Voltage	1500	1250	1000	500	Volts
D.C. Plate Current— Maximum Signal	75	136	150	150	M. A.
D.C. Plate Current— Zero Signal		24	30	70	M. A.
D.C. Grid Voltage	-250	-42	-29	0	
Peak A.F. Grid-to- Grid Voltage		256	248	190	Volts
Load Resistance (Plate to Plate)		21200	15000	6400	Ohms
Plate Dissipation	25	50	45	30	Watts
Plate Efficiency		70	69	60	Percent
Driving Power— (Nominal)		4.2	4.5	3.5	Watts
Power Output		120	105	45	Watts

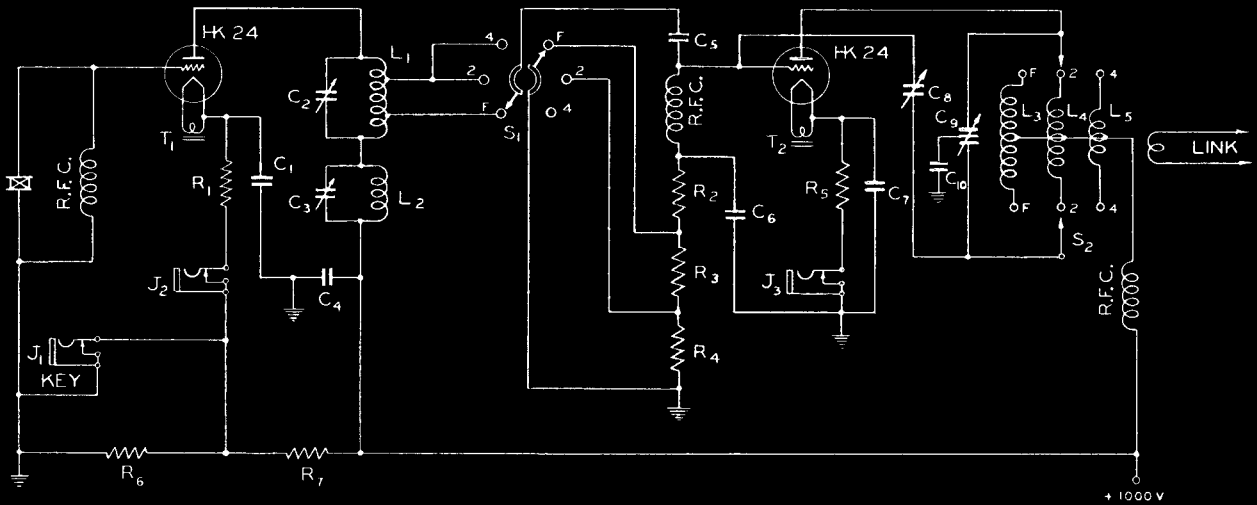
RADIO FREQUENCY TRIPLER AMPLIFIER

(Feedback Voltage Neutralized by
Conventional Methods)

	Maximum Rating Per Tube	Typical Operation, 1 Tube			
D.C. Plate Voltage	1500	1500	1250	1000	Volts
D.C. Plate Current	60	31	36	45	M. A.
D.C. Grid Voltage	-250	-220	-230	-250	Volts
D.C. Grid Current	15	7	9	11	M. A.
Peak R.F. Grid Voltage		295	315	350	Volts
Driving Power		1.9	2.5	3.5	Watts
Plate Dissipation	25	25	25	25	Watts
Tube Efficiency		47	45	45	Percent
Power Output		22	20	20	Watts

Gammatron Tubes

HK-3 BAND EXCITER OR TRANSMITTER



HK-3 BAND EXCITER OR TRANSMITTER

There is a universal need for an exciter or low power transmitter that is inexpensive, easy to build, easy to adjust, and requires a minimum of crystals. The exciter shown on this page has these features and will operate on three bands with a single crystal. It will give sufficient power output to excite a pair of 24 or 54 GAMMATRONS or a single 254 GAMMATRON on 10 meters and does not depend on regenerative action for its operation. Thus, it is not unstable and hard to tune as many of the previously published harmonic amplifiers have been. If desired, high speed keying of the crystal oscillator may be employed. A 160, 80 or 40 meter crystal may be used to give outputs on the fundamental, second and fourth harmonics with approximate respective powers of 50, 35 and 20 watts. The high fourth harmonic output is due to the circuit $C_3 - L_2$ which accentuates this voltage, giving a peaked wave form.

CRYSTAL OSCILLATOR

The crystal oscillator may be safely operated at 1000 volts with a 40 meter crystal, and 160 or 80 meter crystal may be safely operated with 1250 volts on the plate. The power output of the crystal stage is approximately 20 watts. This value depends greatly on the crystal activity. The tank condenser C_1 is tuned slightly to the low capacity side of resonance for best output and least crystal duty. The condenser C_3 is tuned to maximum capacity for operation on the fundamental and second harmonics and for resonance or maximum output of the harmonic amplifier when operated on the fourth harmonic. The oscillator will key excellently with crystals from 1.5 to 4 Mc., and 7 Mc. crystals key well, but are somewhat chirpy. If keying is not desired the resistors R_6 and R_7 may be eliminated and J_2 tied directly to ground.

HARMONIC AMPLIFIER

The excitation to the amplifier is adjusted with the taps on L_1 . For fundamental operation the grid current should be 20 M. A. and the inductance L_1 tapped approximately 28% from the cold end. For second and fourth harmonic operation the coil tap should be approximately 55% from the cold end, and grid currents should be 11 and 4 M. A., respectively. Total cathode current should not exceed on the fundamental, 100 M. A., second, 80 M. A., and fourth har-

monic, 60 M. A. The neutralization should be adjusted with C_8 while operating on the fundamental.

COMPONENTS

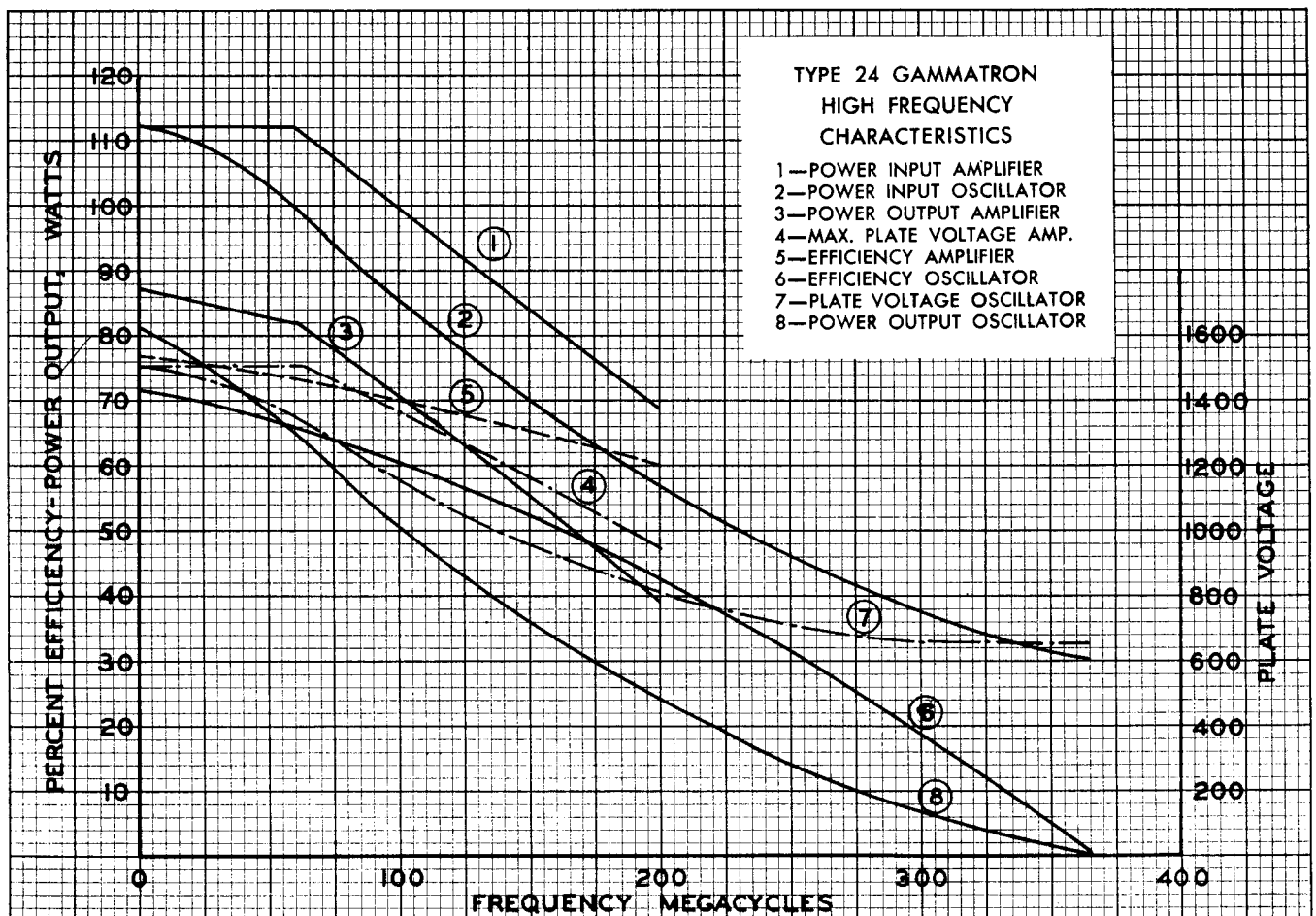
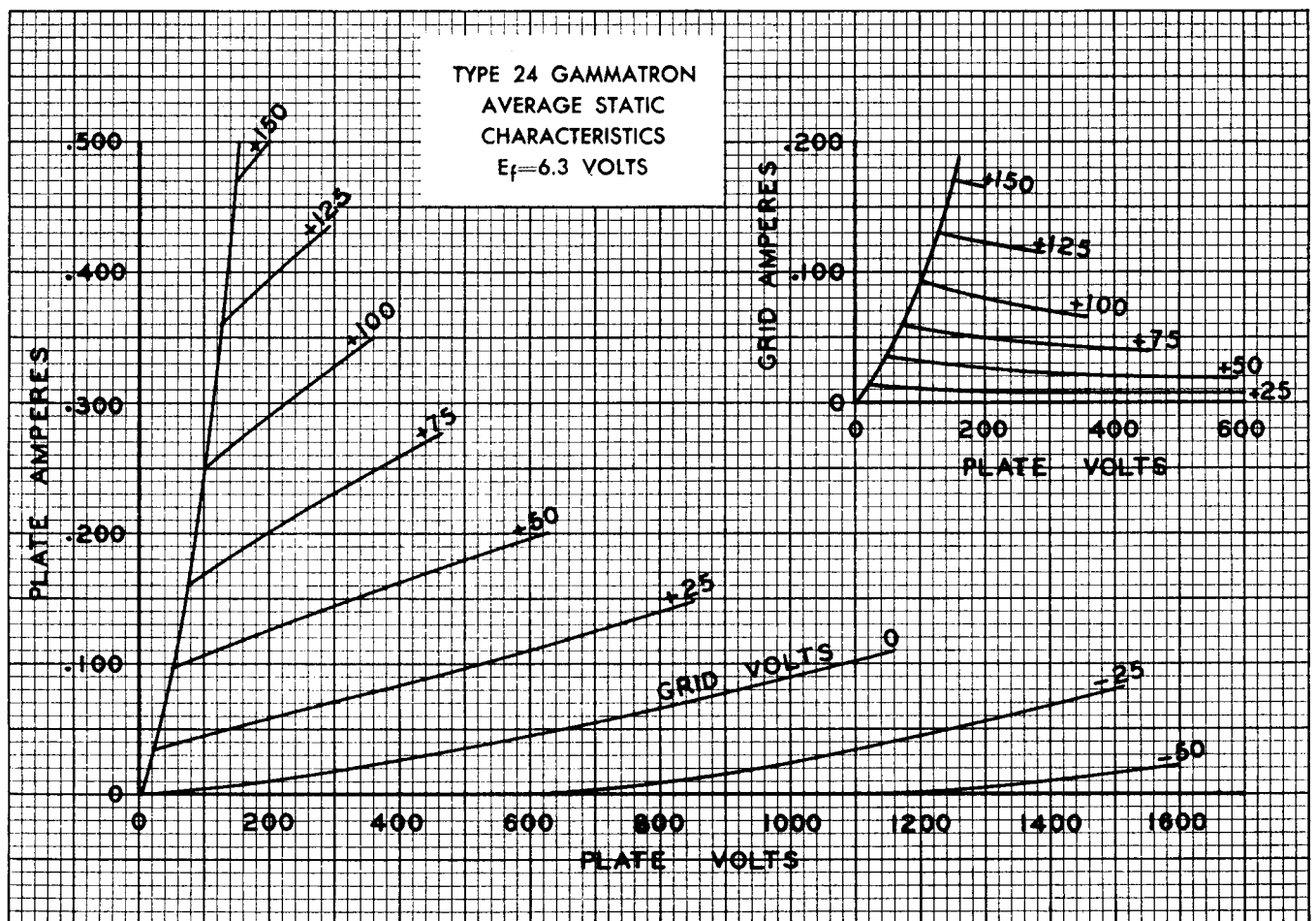
R_1 —1500 Ohm, 10 Watt resistor. R_5 —1000 Ohm, 10 Watt resistor.
 R_2 —2500 Ohm, 5 Watt resistor. R_6 —10000 Ohm, 10 Watt resistor.
 R_3 —17500 Ohm, 5 Watt resistor. R_7 —100000 Ohm, 20 Watt resistor.
 R_4 —20000 Ohm, 1 Watt resistor.

C_1 —.01 mf. 500 Volt mica condenser.
 C_2 —50 mmf. Receiving condenser.
 C_3 —35 mmf. Midget condenser.
 C_4 —.005 mf. 1500 Volt mica condenser.
 C_5 —.000250 mf. 1500 Volt mica condenser.
 C_6 —.01 mf. 500 Volt mica condenser.
 C_7 —.01 mf. 500 Volt mica condenser.
 C_8 —1.4 mmf. neutralizing condenser.
 C_9 —50-50 mm. split stator 2000 Volt condenser
 C_{10} —.005 mf. 1500 Volt mica condenser.
 J_1, J_2, J_3 —Single circuit closing jacks.
 S_1, S_2 —2 pole, 3 point ceramic switches (ganged if desired).
 T_1, T_2 —6.3 Volt, 3 Ampere filament transformers.

COIL DATA

BAND		L_1	L_2	L_3, L_4, L_5
	Diameter	1 1/2		2
	Length	2		2 1/4
160	Turns	80		58
	Wire	24 DSC		22 DSC
	Diameter	1 1/2		2
	Length	1 1/2		2
80	Turns	36		24
	Wire	20 DSC		16 DSC
	Diameter	1 1/2	1 1/2	2
	Length	1 1/2	1 1/2	2
40	Turns	18	26	14
	Wire	18	20	16
	Diameter		1	2
	Length		1 1/2	2
20	Turns		22	9
	Wire		18	14
	Diameter		1	2
	Length		1	2
10	Turns		10	7
	Wire		18	14

Gammatron Tubes



HEINTZ & KAUFMAN LTD.
South San Francisco
California

TYPE HK-24G GAMMATRON
Very High Frequency Triode

PHYSICAL DATA

Plate Cylindrical Tantalum
Grid Vertical Bar Tantalum
Filament Thoriated Tungsten
Max. Height 4-3/8 Inches
Bulb Diameter 1-3/8 Inches
Net Weight 1-1/4 Ounces
Shipping Weight 1-1/4 Pounds

ELECTRICAL DATA

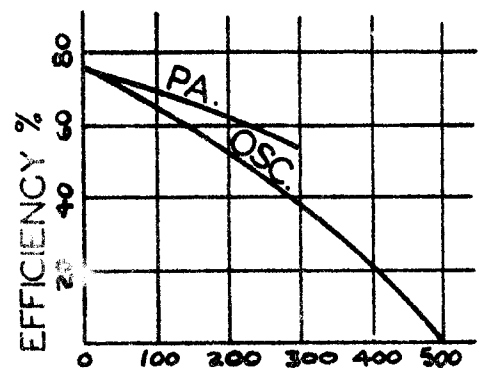
Filament Voltage 6.3 Volts
Filament Current 3.0 Amps.
Amplification Constant..25
Max. Plate Dissipation..25 Watts
Max. Plate Voltage 2000 Volts
Max. Plate Current 75 M. A.
Max. Grid Bias -500 Volts
Max. Grid Current 25 M. A.
Max. DC Plate Input 112 Watts

INTERELECTRODE CAPACITIES

Grid-Plate.....1.6 mmfds
Grid-Filament.....1.8 mmfds
Plate-Filament.....0.2 mmfds

UHF PERFORMANCE

(Continuous Operation Conditions)

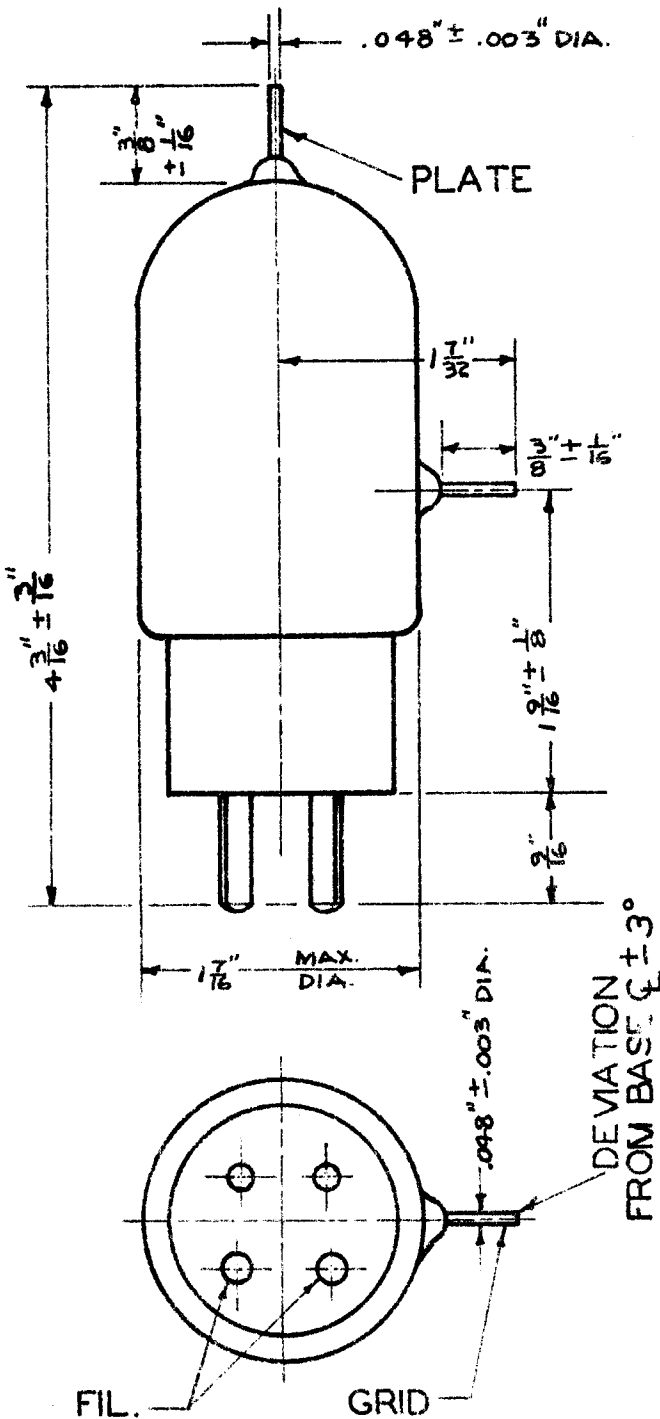


FREQUENCY MEGACYCLES

Max. Plate Input

	60	100	150	200	250	300 mc
112	88	80	70	61	55	Watts
75	59	53	47	41	36	atts

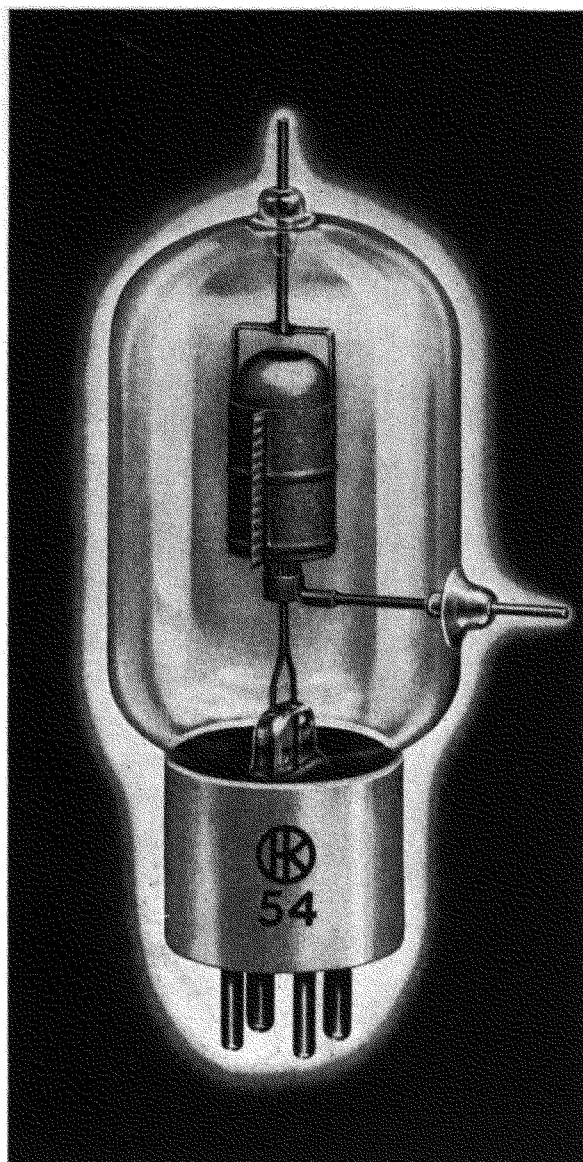
For characteristic curves and operating conditions see data sheet for HK-24



BOTTOM VIEW
SMALL 4 - PIN BASE

Frequency
RFPA Class "C" Unmodulated
RFPA Class "C" Plate Mod.

GAMMATRON TYPE 54



GENERAL PURPOSE TRIODE

50 watt radiation cooled universal triode, medium mu. Special design permits high voltage operation and unusual UHF efficiency.

PHYSICAL DATA

Plate	Cylindrical Tantalum
Grid	Braced Vertical Bar Tantalum
Filament	Thoriated Tungsten
Base	Medium 4 Pin Ceramic Base
Net Weight	2½ Ounces
Shipping Weight	8 Ounces
Maximum Height	5.7 ¹ / ₁₆ Inches
Maximum Diameter	2-1/16 Inches

ELECTRICAL DATA

Filament Voltage	5.0 Volts
Filament Current	5.0 Amps.
Normal Plate Dissipation	50 Watts
Maximum Average Plate Current	150 MA.
Maximum Average Grid Current	30 MA.
Maximum Plate Voltage	3000 Volts
Average Amplification Constant	27

INTERELECTRODE CAPACITANCES

Grid-Plate	1.8 Mmfd.
Grid-Filament	2.0 Mmfd.
Plate-Filament	0.2 Mmfd.

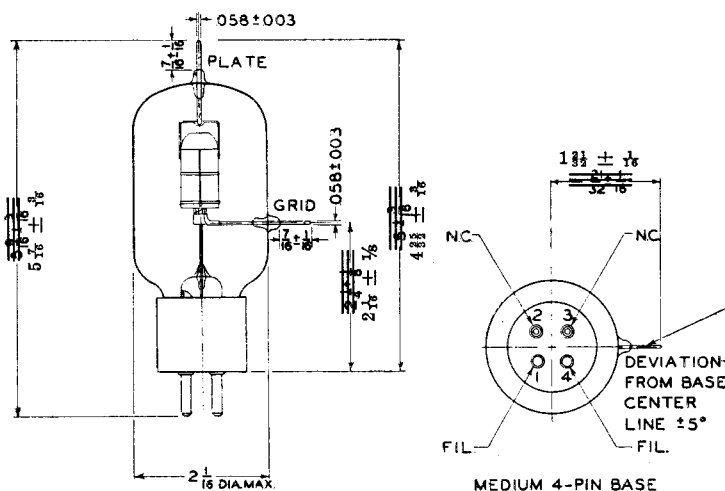
The Type 54 GAMMATRON has amazing power capabilities even though it is small in size. It has very low interelectrode capacities, and it employs a domed plate construction confining the entire electron stream at very high frequencies. Thus, no power is wasted, and the UHF efficiency is unequaled by ordinary tubes. Tantalum elements are cleaned and degassed by Heintz and Kaufman's new and improved pumping process. The "getter" is eliminated, internal insulators are not used, and thus GAMMATRON tubes do not become gassy because every source of gas has been removed.

The 54 GAMMATRON has unusual stamina and is very versatile. Its excellent characteristics suit it as a Class C amplifier for low or ultra high frequencies, Class B audio amplifier, frequency multiplier and crystal oscillator.

The tantalum plate is designed to run hot. Only a perceptible glow can be seen at 25 watts dissipation, and a dull cherry red color at 50 watts dissipation. This is normal, and no damage will result at this temperature. The convenience of the use of the plate color as an indication of proper circuit efficiency and tuning will be appreciated immediately after trying the 54 GAMMATRON.

TYPE HK 54

The information on this and the following page does not represent exact conditions of operation to be imposed for any particular situation. Because tubes are used under many widely different conditions Heintz and Kaufman will gladly furnish information for applications which differ appreciably from the illustrative examples given.



RADIO FREQUENCY POWER AMPLIFIER Class C UNMODULATED*

	Maximum Rating Per Tube	Typical Operation, 1 Tube		
Power Output		250	210	100 Watts
Driving Power		10	9	6 Watts
DC Plate Voltage	3000	3000	2000	1000 Volts
DC Plate Current	150	100	130	135 ma
DC Grid Current	30	25	20	20 ma
DC Grid Voltage	-750	-290	-269	-130 Volts
Peak RF Grid Voltage		465	465	304 Volts
Plate Dissipation	50	50	50	35 Watts
Plate Input	300	300	260	135 Watts

*Carrier conditions for telegraphy.

AUDIO FREQUENCY POWER AMPLIFIER CLASS B*

	Maximum Rating Two Tubes	Typical Operation, 2 Tubes		
Power Output		260	200	140 Watts
Driving Power**		12	10	10 Watts
DC Plate Voltage	2500	2000	1500	1000 Volts
DC Plate Current, Zero Signal		24	40	40 ma
DC Plate Current, Maximum Signal	300	180	198	233 ma
DC Grid Voltage		-70	-45	-25 Volts
Peak AF Grid to Grid Voltage		360	300	295 Volts
Plate Dissipation	100	100	96	91 Watts
Plate Input, Maximum Signal	375	360	296	233 Watts
Load Resistance, Plate to Plate		36000	16800	8500 Ohms
Driver Transformer Ratio***		0.75	0.6	0.6

*All data for two tubes.

**Instantaneous power at crest of cycle; effective power is 1/2 of this value.

***Driver tubes 2 - 6V6 Class A₁. Plate volts 315. The use of inverse feed back is recommended to reduce distortion.

RADIO FREQUENCY POWER AMPLIFIER CLASS C PLATE MODULATED*

	Maximum Rating Per Tube	Typical Operation, 1 Tube		
Power Output		180	147	92 Watts
Driving Power		9	9	9 Watts
DC Plate Voltage	2500	2000	1500	1000 Volts
DC Plate Current	125	110	125	125 ma
DC Grid Current	30	25	30	30 ma
DC Grid Voltage	-750	-250	-140	-130 Volts
Peak RF Grid Voltage		422	310	295 Volts
Plate Dissipation	40	40	40	35 Watts
Plate Input	225	220	188	125 Watts

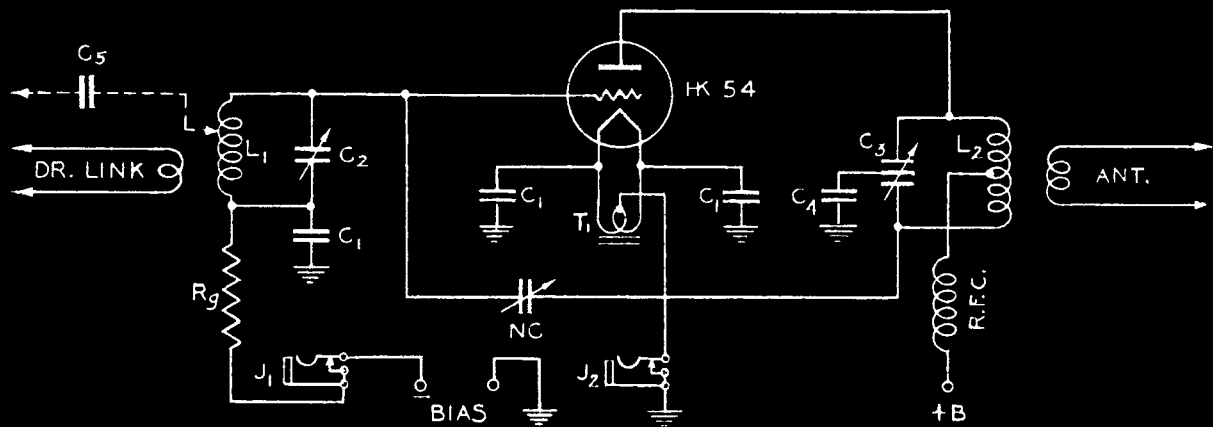
*Carrier conditions for 100% modulation and 60% average value.

RADIO FREQUENCY DOUBLER AMPLIFIER (Feedback neutralized by conventional methods)

	Maximum Rating Per Tube	Typical Operation, 1 Tube			
Power Output		115	105	80	57 Watts
Driving Power		12	12	12	10 Watts
DC Plate Voltage	3000	3000	2000	1500	1000 Volts
DC Plate Current	150	55	77	85	100 ma
DC Grid Current	30	14	15	20	20 ma
DC Grid Voltage	-750	-700	-500	-420	-339 Volts
Peak RF Grid Voltage		835	670	580	510 Volts
Plate Dissipation	50	48	48	48	43 Watts
Plate Input	165	165	155	127	100 Watts

Gammatron Tubes

TYPICAL FINAL AMPLIFIER



This typical final amplifier is capable of a maximum output of 250 watts and requires a driving power of only 10 watts. A small receiving tube such as a 6V6-G is sufficient. It may be link-coupled to the grid circuit or directly coupled with C_5 to the point on L_1 which provides sufficient excitation. It is advisable to supply enough fixed bias to prevent plate current flow under static conditions (see plate curve), and the remaining bias is then developed by the grid current flow through R_g . Thus: DC grid voltage = Fixed Bias + ($R_g \times$ DC grid current).

COMPONENTS

- C_1 — .01 mfd mica, 1000 volt working.
- C_2 — 260 mmfd variable condenser, 1500 volt rating.
- C_3 — 200 mmfd per section, 4500 volt rating variable condenser.
- C_4 — .005 mfd mica, 5000 volt working.
- C_5 — .001 mfd mica, 2500 volt working.
- N.C. — Neutralizing condenser .7 to 4 mmfd.
- J_1 and J_2 — Jacks to measure grid and cathode current.
- R_g — As required.
- T_1 — 5.0 volt, 5 ampere filament transformer.

COIL DATA

Band	L_1	L_2^*
160 Meters	34 Turns #22 Enamel Close Wound Diameter 1½ Inches Length 1 Inch	54 Turns #18 DCC Diameter 2½ Inches Length 4 Inches
80 Meters	20 Turns #22 Enamel Diameter 1½ Inches Length 1 Inch	34 Turns #16 Diameter 2½ Inches Length 4 Inches
40 Meters	13 Turns #22 Enamel Diameter 1½ Inches Length 1 Inch	20 Turns #12 Diameter 2½ Inches Length 4 Inches
20 Meters	8 Turns #22 Enamel Diameter 1½ Inches Length 1 Inch	10 Turns #12 Diameter 2½ Inches Length 3 Inches
10 Meters	5 Turns #16 Enamel Diameter 1½ Inches Length 1 Inch	6 Turns #12 Diameter 2½ Inches Length 3½ Inches

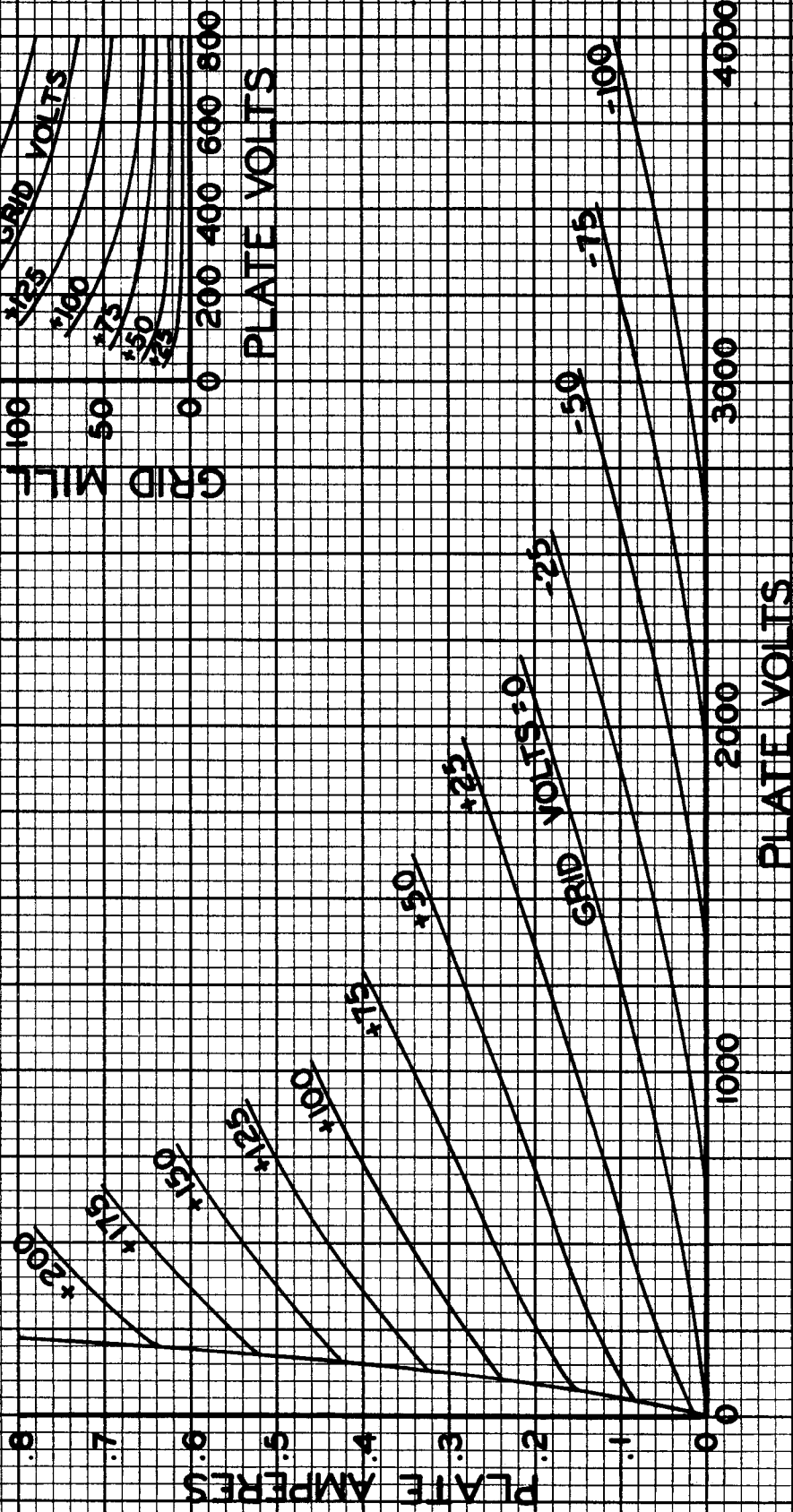
*Length includes ½ inch space at center for antenna or transmission line link windings.

ULTRA HIGH FREQUENCY PERFORMANCE

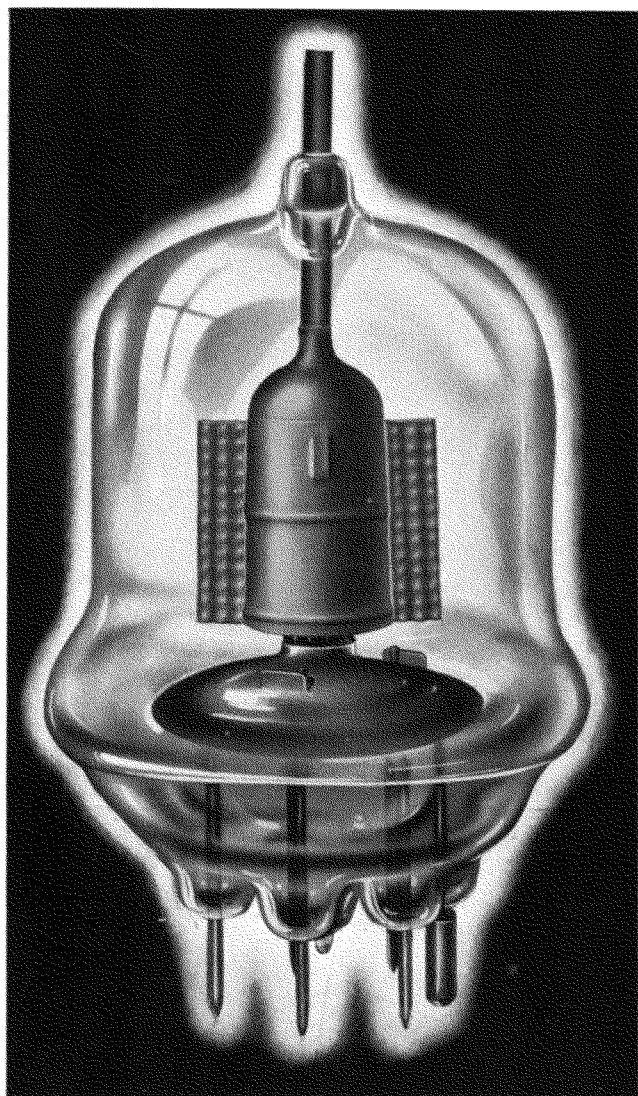
FREQUENCY	30	60	120	200 mc
Class C Unmodulated				
Max. Input	250	215	180	140 Watts
Max. Plate Volts.....	3000	2700	2500	2000 Volts
Typical Plate Efficiency.....	80	77	72	64 Percent
Class C Plate Modulated				
Max. Input	210	180	150	115 Watts
Max. Plate Volts.....	2500	2200	2000	1700 Volts

Gammatron Tubes

TYPE 54 GAMMATRON
AVERAGE STATIC
CHARACTERISTICS



GAMMATRON TYPE 57



BEAM PENTODE

50 watt radiation cooled beam pentode. Exceptional very high frequency performance.

ELECTRICAL DATA

Plate Dissipation	50 Watts
Maximum Screen Input	25 Watts
Filament Voltage	5.0 Volts
Filament Current	5.0 Amps.

INTERELECTRODE CAPACITIES

Plate-Grid Capacity	.05 Mmfd.
Input Capacity	7.29 Mmfd.
Output Capacity	3.13 Mmfd.

PHYSICAL DATA

Plate	Enclosed Cylindrical Tantalum
Grids	Vertical Bar Tantalum
Filament	Thoriated Tungsten
Socket	Johnson #101 or #247
Envelope	Nonex Glass
Net Weight	2 $\frac{1}{4}$ Ounces
Shipping Weight	6 Ounces
Maximum Height	4 $\frac{1}{16}$ Inches
Maximum Diameter	2 $\frac{3}{8}$ Inches

The type HK-57 is capable of very high frequency operation and does not require neutralization. It has very low driving power requirements, will stand high plate and screen voltages, and will stand large momentary overloads. These features are made possible through the use of tantalum plate and grid elements and an advanced design by Heintz and Kaufman Ltd. engineers. The HK-57 is the only multi-element tube in its class capable of this kind of performance.

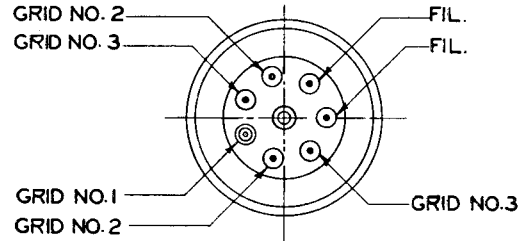
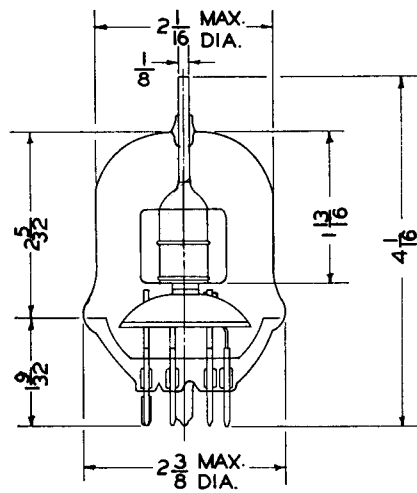
High mutual conductance in combination with high voltage capabilities makes the grid driving power requirements of the HK-57 very low. And under many conditions the power consumed is negligible. This feature reduces the number and size of the preliminary stages required in any transmitter resulting in savings and advantages that are obvious.

The plate and grid leads are short and sturdy, resulting in low lead inductance. The suppressor grid and screen grid are each supported with two parallel leads. All four leads are terminated on the base so that they may be individually bypassed to ground. The feed back capacity is extremely low and thus it is possible to operate the HK-57 even at very high frequencies without neutralization. This feature makes the HK-57 adaptable to instant band switching circuits and such circuits may be designed with a minimum of controls.

Installation into practical circuits is facilitated by the unique physical design of the HK-57. The input and output circuits are readily isolated and complete shielding is assured when the base shell is grounded.

TYPE HK-57

The information on this and the following page does not represent exact conditions of operation to be imposed for any particular situation. Because tubes are used under many widely different conditions Heintz and Kaufman will gladly furnish information for applications which differ appreciably from the illustrative examples given.



RADIO FREQUENCY POWER AMPLIFIER CLASS "C" UNMODULATED

	Maximum Rating Per Tube	TYPICAL OPERATION, 1 TUBE*			
		250	166	125	Watts
Power Output		.18	.15	.14	Watts
Driving Power		3000	2000	1500	Volts
D.C. Plate Volts	3000	100	110	105	M. A.
D.C. Plate Current	150	-0-	+30	+30	Volts
D.C. Suppressor Voltage		-0-	1	4	M. A.
D.C. Suppressor Current		450	450	450	Volts
D.C. Screen Voltage	500	2	2	4	M. A.
D.C. Screen Current	20	-175	-145	-145	Volts
D.C. Control Grid Voltage	400	1	1	1	M. A.
D.C. Control Grid Current	15	195	160	160	Volts
Peak R.F. Control Voltage		50	50	32	Watts
Plate Dissipation	50†	300	216	157	Watts
D.C. Plate Input	300				

*Other values to obtain similar results may be used provided the maximum ratings are not exceeded.

†Continuous rating. Intermittent rating 75 watts.

RADIO FREQUENCY POWER AMPLIFIER CLASS "C" PLATE MODULATED

(100% Modulation Peaks, 60% Average Value)

	Maximum Rating Per Tube	TYPICAL CARRIER CONDITIONS, 1 TUBE			
		200	135	125	Watts
Power Output		.18	.2	.2	Watts
Driving Power		2500	2000	1500	Volts
D.C. Plate Volts	3000	96	88	105	M. A.
D.C. Plate Current	135	-0-	+30	+30	Volts
D.C. Suppressor Volts		-0-	3	4	M. A.
D.C. Suppressor Current		450	450	450	Volts
D.C. Screen Volts	500	2	2	4	M. A.
D.C. Screen Current	20	-175	-145	-145	Volts
D.C. Control Grid Volts	400	1	1.5	1.5	M. A.
D.C. Control Grid Current	15	190	165	165	Volts
Peak R.F. Control Voltage		40	40	32	Watts
Plate Dissipation	40	240	175	157	Watts
D.C. Plate Input	250				

Gammatron Tubes

RADIO FREQUENCY POWER AMPLIFIER CLASS "C" SUPPRESSOR GRID MODULATED

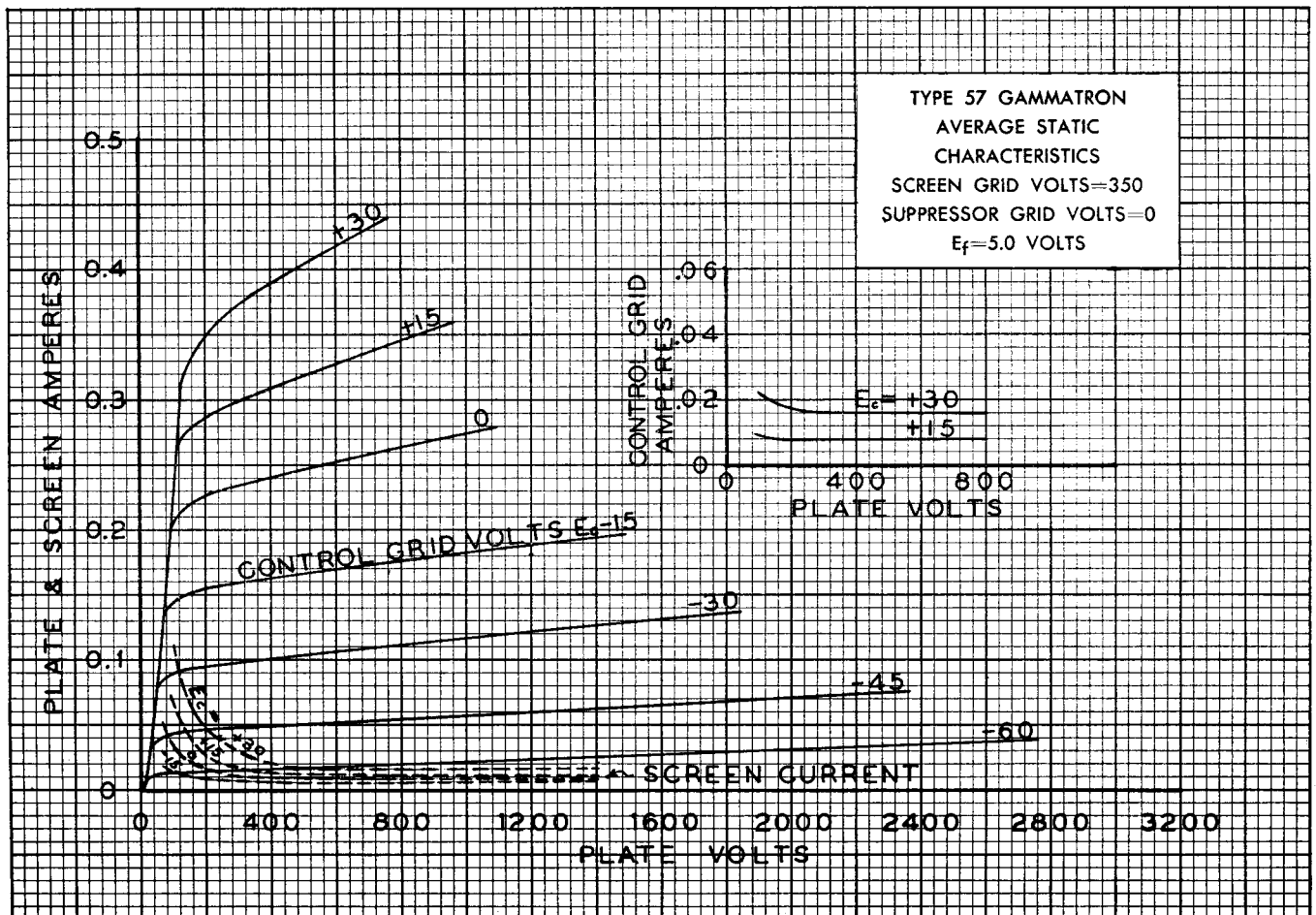
TYPICAL CARRIER CONDITIONS, 1 TUBE

Power Output	90	50	23	Watts
Driving Power	0.6	0.3	0.2	Watts
Audio Power	100	140	121	Milliwatts
D.C. Plate Voltage	2000	1500	1000	Volts
D.C. Plate Current	80	58	40	M. A.
D.C. Suppressor Voltage	-190	-150	-120	Volts
D.C. Screen Voltage*	450	400	350	Volts
D.C. Screen Current	14	11	12	M. A.
Screen Series Resistor†	110,000	100,000	56,000	Ohms
D.C. Control Grid Voltage	-240	-210	-180	Volts
D.C. Control Grid Current	2.5	1.5	1.0	M. A.
Peak R.F. Driving Voltage	265	230	200	Volts
Peak A.F. Modulating Voltage	240	182	160	Volts
Plate Dissipation	50	25	17	Watts
Suppressor Circuit Resistance‡	300,000	120,000	100,000	Ohms
Modulation Percentage	94	95	94	%

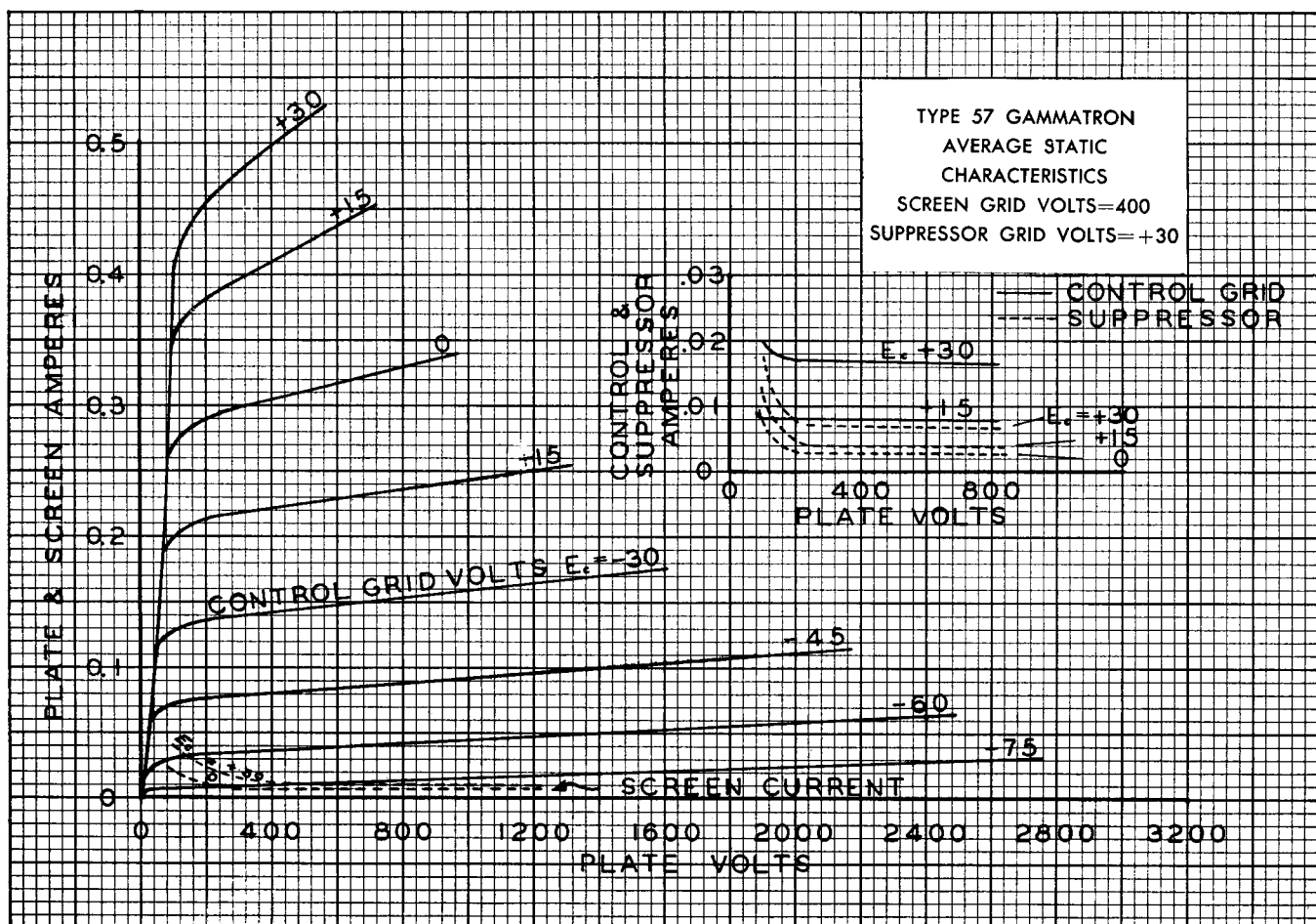
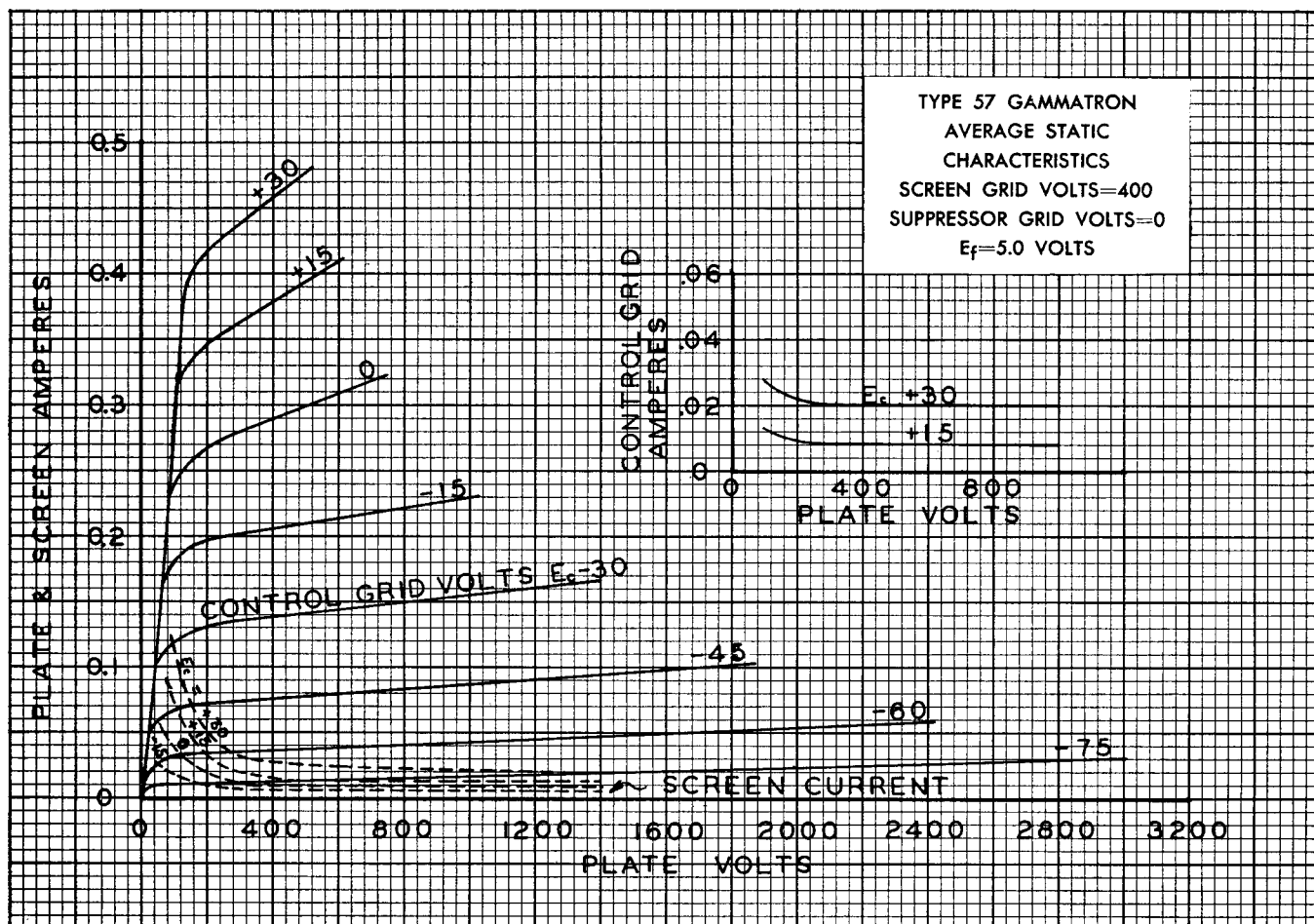
*Screen voltage obtained from plate source through specified dropping resistor.

†Screen series resistor value specified provides the regulation required.

‡Load shown to modulator.



Gammatron Tubes



GAMMATRON

11-36

Engineering Data Sheet
HK-154-1
(Tentative)

GAMMATRON

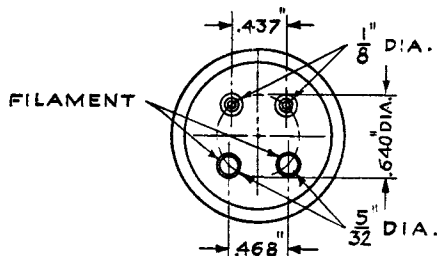
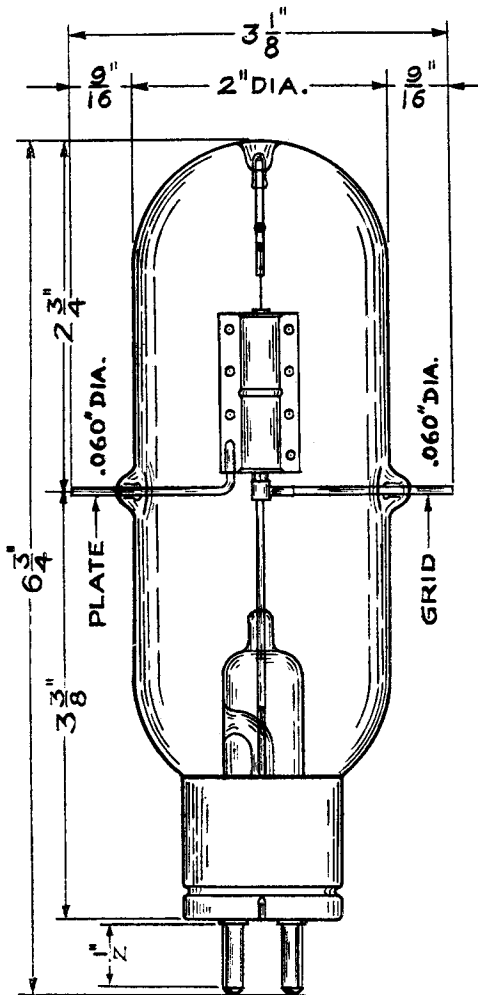
TYPE HK-154

PHYSICAL DATA

Plate	Tantalum
Grid	Tantalum
Filament	Thoriated Tungsten
Blank	Nonex Glass
Base	Medium 4 Pin
Base Insulator	Ceramic
Net Weight	3½ Ounces
Shipping Weight	3 Pounds
Maximum Height	6¾ Inches
Maximum Diameter	3⅛ Inches

ELECTRICAL DATA

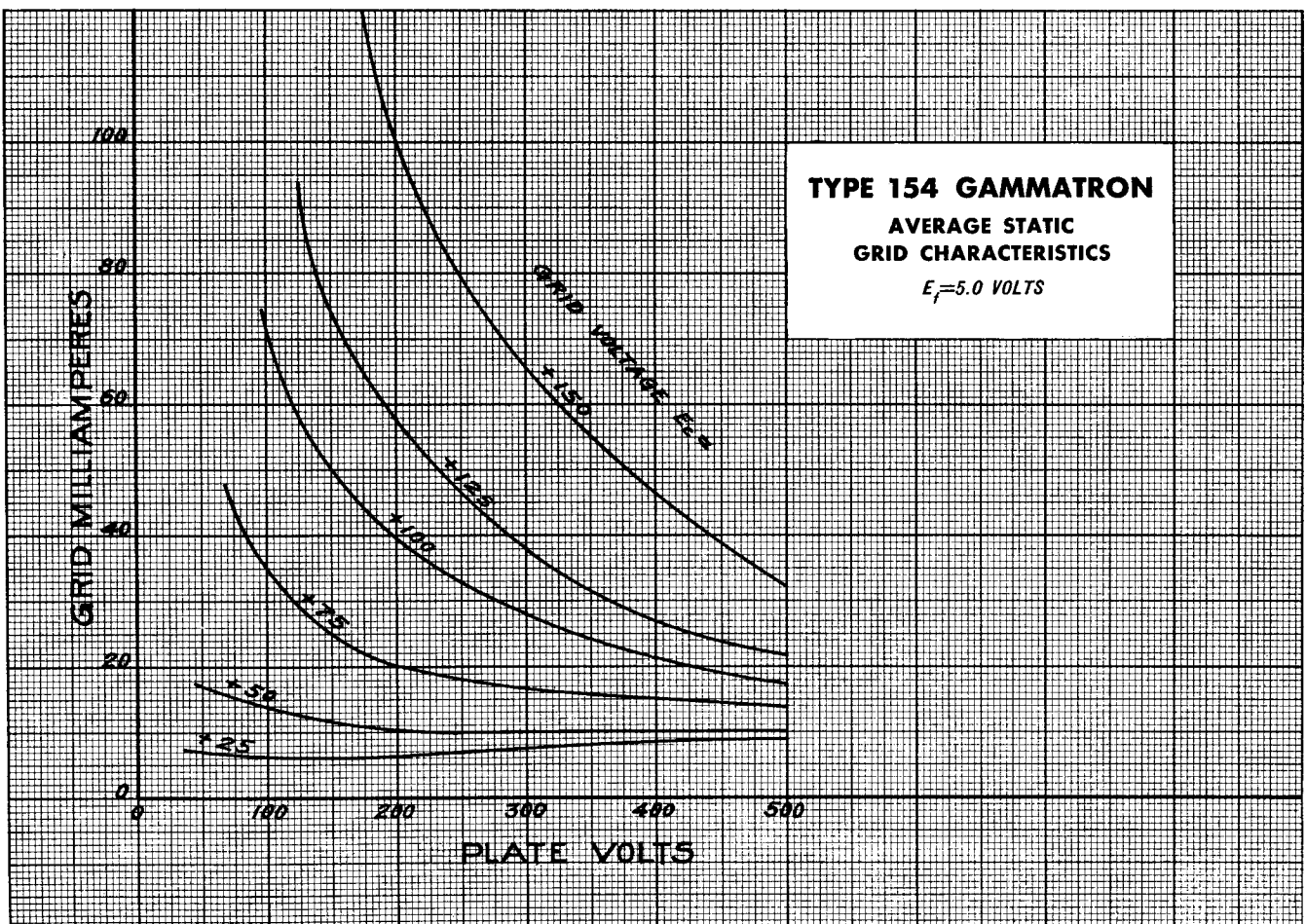
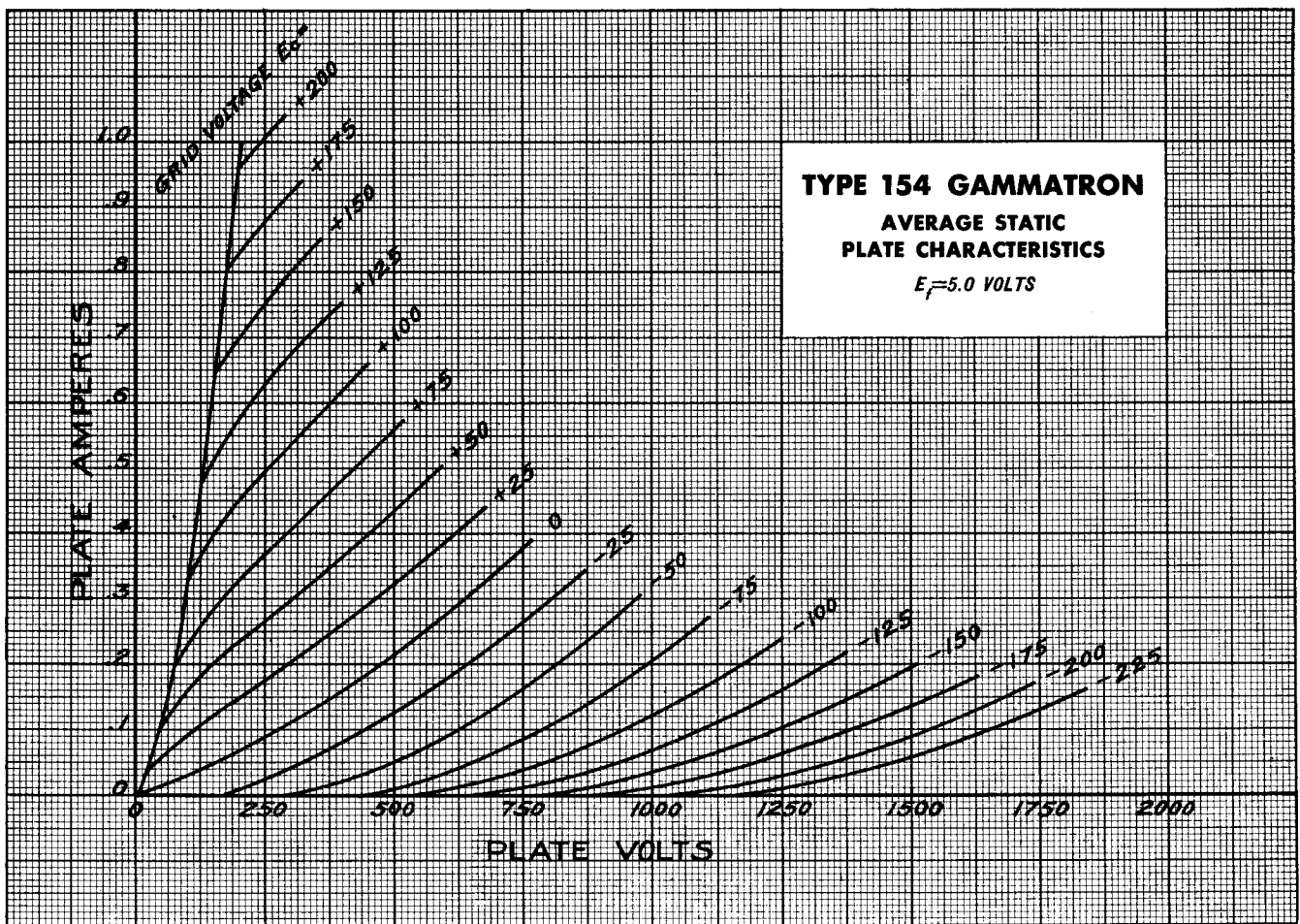
Filament Voltage	5.0 Volts
Filament Current	6.5 Amps.
Normal Plate Dissipation	50. Watts
Maximum Average Plate Current	175. Ma.
Maximum Plate Voltage	1500. Volts
Maximum Average Grid Current	30. Ma.
Average Plate Impedance	1750. Ohms.
Average Amplification Constant	6.7
Grid-Plate Capacitance	5.9 mmfd.
Grid-Filament Capacitance	4.3 mmfd.
Plate-Filament Capacitance	1.1 mmfd.



BOTTOM VIEW OF BASE



GAMMATRONS HAVE TANTALUM PLATES and GRIDS!



TYPE HK-154

APPLICATIONS AS A RADIO FREQUENCY AMPLIFIER

Radio Frequency Amplifier—Class "C" (Telegraphy)

The Type HK-154 GAMMATRON is an exceptionally fine radio frequency tube. Used in Class C, surprisingly high outputs are secured at moderately low plate voltages. The tube is remarkably easy to drive. Compare the ratings of other tubes of equivalent size with the "HK-154", which will deliver 200 watts at 1500 plate volts and 125 watts at only 1000 plate volts! And all its ratings apply at 60. megacycles (5 meters) as well!

In the Class C amplifier the tube is biased more negative than necessary for plate current cut-off. The grid is driven positive for a part of each cycle of excitation. This gives a plate current impulse of short duration which develops the output power in the tuned plate circuit. Unusually high plate efficiencies are secured by this means.

Any bias more negative than that required for cut-off gives Class C operation. The reasonably economical bias, however, is that which gives a fairly high plate efficiency with a minimum of driving power. Such a bias is achieved when approximately *twice* the cut-off bias is used. Plate efficiencies of 70-80% can be secured.

This bias may be secured in several ways: namely, from a separate bias rectifier, from a bias battery, by means of a grid leak, or by using extra plate voltage and securing the bias across a resistance from filament to negative terminal of the plate supply. Any of these methods are satisfactory, although one to be recommended highly is that of using a combination of battery bias and grid leak bias. With this last method it would be desirable to use at least 150 volts of negative battery bias, plus the grid leak bias. A D.C. grid current meter should always be used, bypassing it to radio frequency with at least a 0.01 mfd. condenser. The excitation should be adjusted to 20. milliamperes *per tube*. Now, to calculate the correct grid leak subtract the battery bias voltage from the total bias voltage required, then divide the re-

maining voltage by the *total* grid current in amperes (milliamperes divided by 1000) to determine the correct grid leak (in ohms). Should insufficient driving power be available, decrease the grid leak until the correct grid current of 20 milliamperes per tube flows, being careful that it is not decreased past the value giving 50 watts plate dissipation.

As an indication of plate dissipation let us state that 20 watts just causes the plate to glow, 35 watts gives a dull red, while 50 watts is a medium red.

Neutralizing is extremely important. Complete neutralizing requires that stray coupling be a minimum. Keeping leads as short as possible is the first requisite. Proper location of coils and shields (if used) is necessary. Many times split-stator condensers in conjunction with a symmetrical layout provide the only solution when using two tubes in the Class C stage.

Worthy of particular mention at this point is the "double side-arm" construction of the Type HK-154 GAMMATRON. This aids materially in doing away with long leads, even to the extent of eliminating need of wires running to the tops of the tubes.

When operating the "HK-154" at frequencies greater than 60 megacycles (5 meters) it is advisable to reduce the plate voltage and power. Operation at 250 megacycles (1-1/5 meters) may be attained with 600 plate volts.

Class "C" (Telephony)

The use of the Type HK-154 GAMMATRON in Class C for radio telephone (using plate or high level modulation) is exactly the same as just described for Class C telegraphy except that the plate voltage varies above and below the plate supply value with the audio frequency modulation. Due to the increased values on modulation peaks a maximum of 1250 plate supply volts should not be exceeded. Operating conditions should be determined as explained above for the plate voltage available. In order to attain 100% modulation, audio power equal to one-half the total Class C plate power input should be secured.

R. F. POWER AMPLIFIER—CLASS "C"

TABLE I

(SINGLE TUBE)

Plate Supply Volts	Plate Milli-amperes	Grid Bias Volts	Grid Milli-amperes	Effective Excitation Volts	Driving Power Watts	Power Input Watts	Load Resistance Ohms	Power Output Watts	Plate Loss Watts	Plate Efficiency Per Cent
750	175	-260	20	310	9	131	1920	85	46	65
1000	175	-380	20	420	10	175	2480	127	48	73
1250 ₁	170	-460	20	470	12	212	3370	162	50	76
1500 ₂	167	-590	20	560	15	250	4180	200	50	80

₁Maximum rated plate voltage for modulated amplifier.

₂Maximum rated plate voltage for c.w. telegraph.

GAMMATRONS HAVE TANTALUM PLATES and GRIDS!

RADIO FREQUENCY AMPLIFIER—CLASS "B" (LINEAR)

It is frequently desirable to build a transmitter of moderate power which requires practically no audio frequency power for modulation. The attendant cost of high powered audio equipment for modulation of a Class C amplifier many times imposes this limitation. Class B radio frequency amplification offers the most likely solution.

Should a low-powered radio telephone be available complete with audio system, a stage of one or more Type HK-154 GAMMATRONS may be added to its output, using the modulated low-power transmitter as the driver. Carrier output of 25-30 watts power per

tube may then be secured, the "HK-154" amplifier satisfactorily handling up to 100% modulation.

The carrier radio frequency power required is low, being of the order of three to five watts, dissipating one-half to two-thirds of the input power in a non-inductive resistor shunting the driving circuit. This insures good regulation from the driver. As with Class C, neutralization is exceedingly important and may frequently be facilitated through the use of two tubes in the Class B radio stage, arranging the tubes in a symmetrical manner with split-stator condensers and all leads as short as possible.

RADIO FREQUENCY AMPLIFIER PERFORMANCE—CLASS "B"

TABLE II CARRIER WITH 100% MODULATION (SINGLE TUBE)

Plate Supply Volts	No-Signal ₁ Plate Milliamps.	Plate Current Milliamps.	Grid Bias Volts	Carrier Excitation Peak Volts	Peak Driving ₂ Power Watts	Load Resistance Ohms	Carrier Output Watts	Plate Loss Watts	Plate Efficiency Per Cent
750	40	75	-100	108	5	2000	18	48	28
1000	30	75	-155	127	5	3750	25	50	33
1250	25	61	-210	150	5	5700	26	50	34
1500	20	52	-265	175	5	8000	28	50	36

Arithmetic sum of 2nd, 3rd, and 4th harmonics of modulated wave are not greater than 10% at 100% modulation, and under 7% at 75% modulation.

₁Lower no-signal plate currents will increase distortion.

₂At crest of audio cycle with 100% modulation.

RADIO FREQUENCY AMPLIFIER—GRID MODULATED

It is frequently desirable to use the HK-154 GAMMATRON with grid modulation. The audio system required to effect radio telephone operation is negligible.

The D.C. grid bias for such operation should be of the order of 1.5 to 2.0 times that given in the table above for Class B linear operation. The resultant carrier output is comparable with or slightly less than that in the table. The load resistance is approximately the same.

As with a Class B linear amplifier the driver should have good regulation. This means that seven to ten

watts of radio frequency power should be available and the r.f. input circuit loaded with a non-inductive resistor of a value which will absorb one-half to two-thirds of the excitation power. The audio power required is from three to five watts.

Frequently a cathode resistor in combination with fixed bias is used to increase the efficiency and improve the linearity of the grid modulated amplifier. Such methods have been discussed in various radio publications and it is suggested that should the reader be interested further he refer to current publications.



GAMMATRONS HAVE TANTALUM PLATES and GRIDS!

TYPE HK-154

APPLICATIONS AS AN AUDIO AMPLIFIER

Audio Frequency Amplifier—Class "A"

The Type HK-154 GAMMATRON is an excellent audio power amplifier having an exceedingly low plate resistance and is suitable for comparatively low plate voltage operation. The extremely high mutual conductance insures high power outputs.

Plate dissipation is limited to 50 watts, which in turn makes the tube ideally suited for large public address systems and high quality audio modulator use where class "A" quality is desired. The actual plate dissipation wattage may be judged by the glow of the plate. When judging by glow 20 watts is just visible, 35 watts gives a dull red and 50 watts shows a medium red.

Load resistance is an important factor since its appreciably affects the audio power output and the distortion (quality). Ordinarily it is advisable to use a load of approximately twice the plate resistance of the tube unless limited by plate dissipation. A higher load

resistance reduces the distortion but also reduces the power output.

Bias affords a very satisfactory control over the variations which may occur between individual tubes. An adjustment of the bias to obtain the proper plate current (as listed below) at a given voltage will assure correct operation. Where two tubes are used in push-pull individual bias adjustments are sometimes provided to secure complete balancing of plate current.

Plate voltages from 500 to 1250 are recommended for the Type HK-154 GAMMATRONS, higher values being of little benefit. Should difficulty be experienced due to excessively high plate currents at various voltages, the trouble can frequently be traced to oscillation or radio frequency pickup. This is sometimes caused by using a grid leak having considerable inductance.

Driving power with Class A operation is practically nil, maximum output being available when the grid swing goes to zero bias.

**TABLE III CLASS "A" AUDIO AMPLIFIER PERFORMANCE
(SINGLE TUBE)**

Plate Supply Volts	Plate Milli-amperes	Grid Bias Volts	Plate Input Watts	Load Resistance Ohms	Power Output Watts	Plate Efficiency Per Cent	Per Cent Second Harmonic
500	60	- 45	30	5,000	3.5	12	6
750	67	- 87	50	6,500	9.0	18	7
1000	50	-137	50	15,000	13.5	27	8
1250	40	-190	50	22,500	15.5	31	7

**CLASS "A" AUDIO PUSH-PULL AMPLIFIER PERFORMANCE
(TWO TUBES)**

TABLE IV

Plate Supply Volts	Plate Milli-amperes	Grid Bias Volts	Plate Input Watts	Plate-to-Plate Load Ohms	Power Output Watts	Plate Efficiency Per Cent	Per Cent Third Harmonic
500	100	- 50	50	10,000	7	14	3
750	133	- 87	100	10,000	20	20	3
1000	100	-137	100	17,000	35	35	4
1250	80	-190	100	30,000	40	40	4

GAMMATRONS HAVE TANTALUM PLATES and GRIDS!

AUDIO FREQUENCY AMPLIFIER—CLASS "B" MODULATOR

For high audio output Class B operation is necessary. Outputs of the order of 250 watts of audio frequency power may be secured by using a pair of Type HK-154 GAMMATRONS. In this manner of operation only one tube works at a time, the other tube idling during approximately half of each audio frequency cycle. Power efficiencies are practically doubled with this system. Two tubes are required, however, using a circuit similar to that used with push-pull.

To secure maximum output sufficient bias is used to keep the no-signal plate current quite low. When input signal is applied the plate current increases considerably. This plate current variation requires a plate power supply of very good regulation in order to maintain the voltage constant. Usually mercury vapor types of rectifier tubes and low resistance chokes are used to attain this regulation.

Likewise, the grid current and grid load fluctuate so that ample driving power is needed in order that the tube input circuit changes will not appreciably affect the input audio frequency wave. A low impedance driver should, therefore, be used as this type of driver gives the best regulation. For this reason it

is unwise to use tubes connected in any manner except as triodes. (Avoid tetrode and pentode circuits). The Type HK-154 GAMMATRON is truly easy to drive, requiring only 10 watts peak driving power.

Due to the manner in which Class B operates the plate-to-plate output load resistance is *four* times the optimum single plate load resistance. Therefore, the secondary load impedance may be considered as acting on a single tube through one-half the primary.

When operating tubes in Class B audio it is wise to use battery bias if possible. If a separate bias rectifier is provided, make certain that the bleeder current is fairly high so that the grid current variation will not materially affect the bias voltage. Bypass the bleeder resistance with a large (8. mfd. or more) condenser to insure best results. If oscillation is encountered, as indicated by high no-signal plate current, load *each* half of the input transformer secondary with about 50,000 ohms.

The table below gives average operating data, no allowance being made for transformer losses. The driver tubes are mentioned only in the way of a suggestion, many other equivalently rated tubes being satisfactory.

CLASS "B" AUDIO AMPLIFIER PERFORMANCE

TABLE V
(TWO TUBES WITH MAXIMUM SIGNAL APPLIED)

(Total arithmetic sum of 3rd, 5th, 7th, and 9th harmonics will not exceed 10%)

Plate Potential Supply Volts	No-signal ¹ Plate Milli-amperes	Grid Bias in Volts	Plate-to-Plate Load Resistance Ohms	Grid-to-Grid Peak Signal Volts	Peak ² Driving Power Watts	Plate Current Milli-amperes	Power Output in Watts	Plate ³ Loss in Watts	Plate Efficiency in Per Cent
750	80	-100	4,000	430	10	350	150	112	57
1000	60	-155	7,500	510	10	300	200	100	66
1250	50	-210	11,400	600	10	256	223	100	69
1500	40	-265	16,000	700	10	230	250	95	72

¹Lower no-signal plate currents will cause somewhat higher distortion.

²Instantaneous peak power in watts drawn by grid at crest of wave. Effective power is one-half this value.

³Plate loss may be slightly greater at lower signal levels.

Driver Transformer Ratio With Suggested Driver

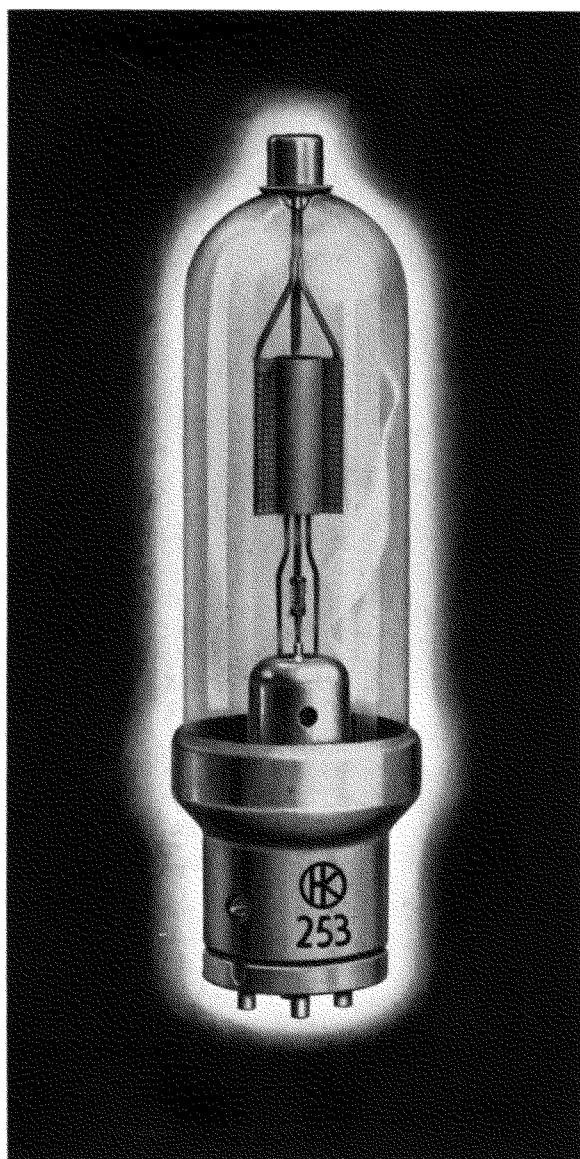
Pair of 2A5 or 42 Tubes

Push-Pull Triode Connection (Screen Tied to Plate)
350 V. on Plate With *Fixed Bias*

Gammatron Plate Voltage	Transformer Turns Ratio
750	1.25:1
1000	1.00:1
1250	0.90:1
1500	0.75:1

GAMMATRONS HAVE TANTALUM PLATES and GRIDS!

GAMMATRON TYPE 253



HIGH-VACUUM HALF-WAVE RECTIFIER

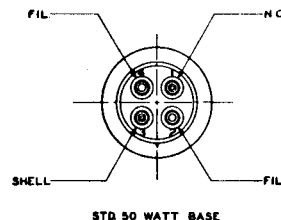
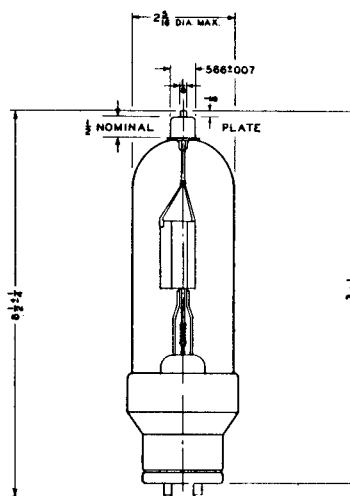
PHYSICAL DATA

Plate	Tantalum
Filament	Thoriated Tungsten
Blank	Nonex Glass
Base	Standard Fifty Watt
Net Weight	9 Ounces
Shipping Weight	4 Pounds
Max. Height	8 $\frac{3}{4}$ Inches
Max. Diameter	2 $\frac{1}{2}$ Inches

ELECTRICAL DATA

Filament Voltage	5.0 Volts
Filament Current	10 Amps.
Max. Peak Inverse Voltage	15,000 Volts
Max. Peak Plate Current	3.0 Amps.
Max. Average Plate Current	.35 Amps.

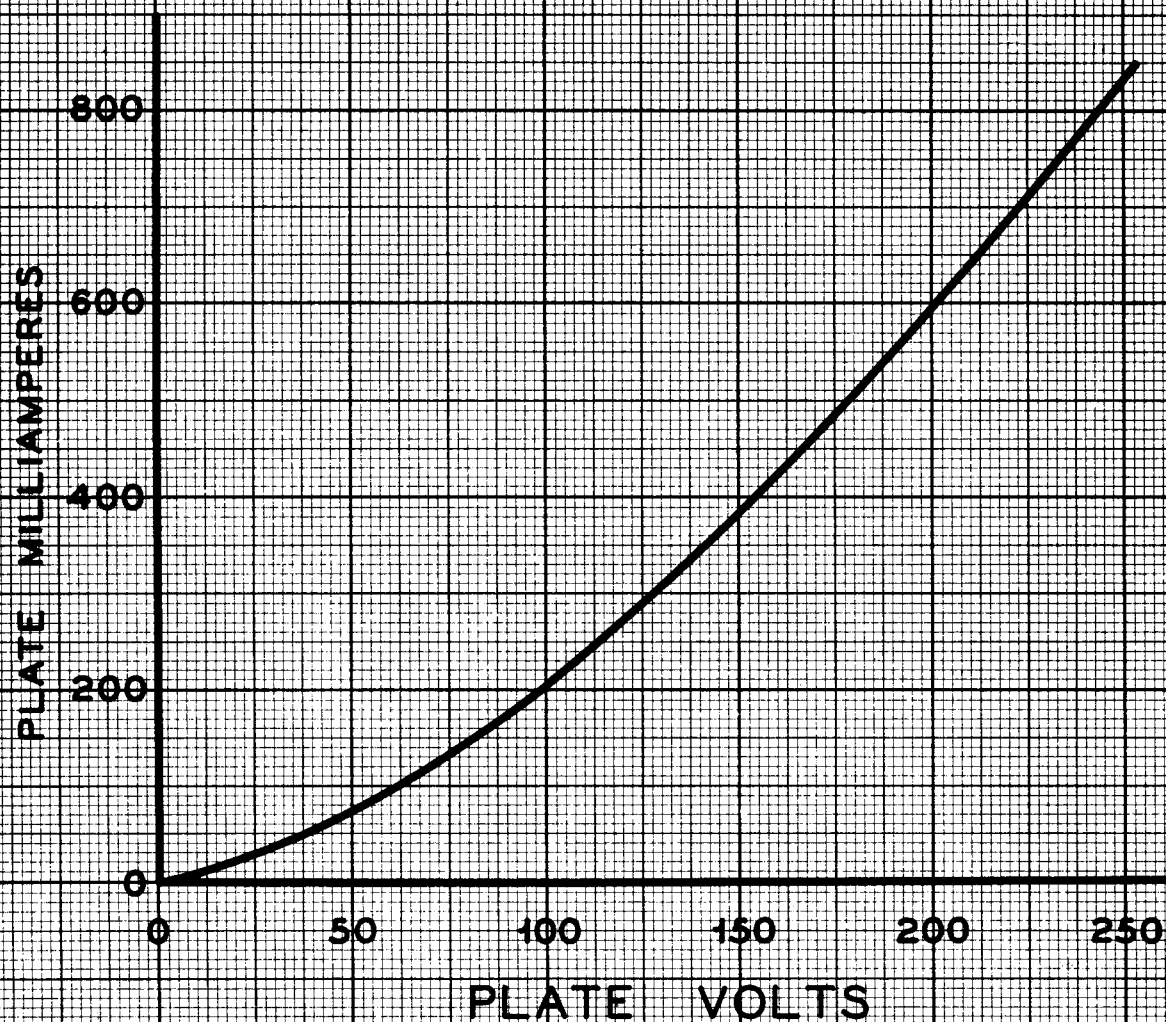
The 253 GAMMATRON is a half-wave high-vacuum rectifier with a thoriated tungsten filament. It has excellent voltage regulation because of close filament to plate spacing. It will stand high inverse plate voltages because of its superior vacuum. No time delay is necessary since the thoriated tungsten filament is ready for operation immediately after application of voltage. The starting characteristics of the 253 are not affected by extreme cold nor is the inverse voltage rating reduced by excessive temperatures as is the case with mercury vapor rectifiers.



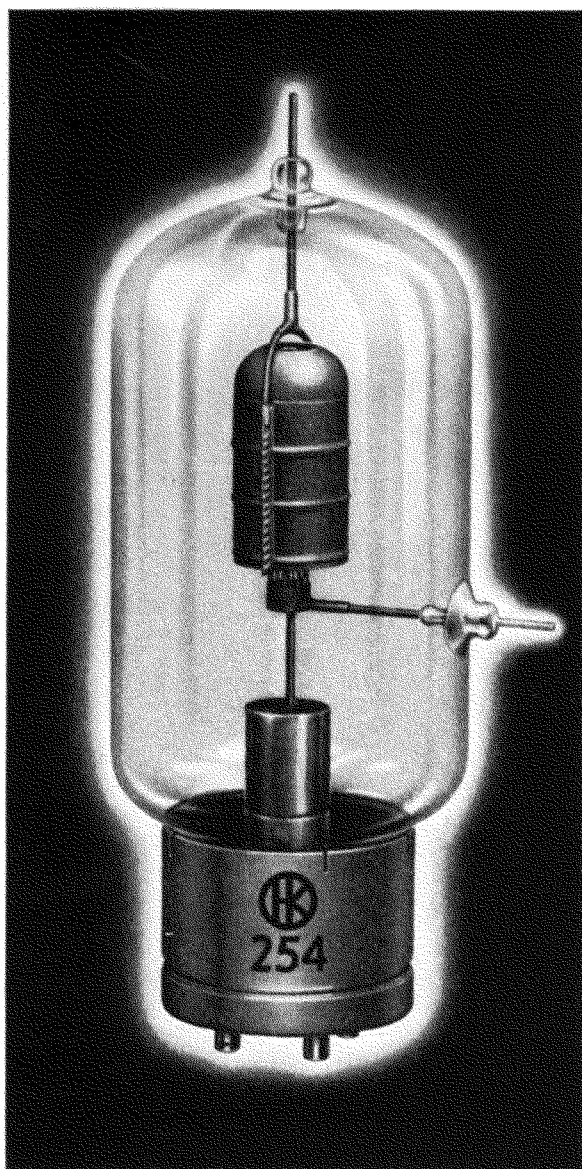
TYPE 253 GAMMATRON

AVERAGE STATIC
CHARACTERISTIC

$E_f = 5.0$ volts



GAMMATRON TYPE 254



GENERAL PURPOSE TRIODE

Medium mu universal triode, 100 watt radiation cooled tantalum plate. Special design permits high voltage operation and unusual VHF efficiency.

PHYSICAL DATA

Plate	Cylindrical Tantalum
Grid	Braced Vertical Bar Tantalum
Filament	Thoriated Tungsten
Net Weight	5 Ounces
Net Weight	6½ Ounces
Shipping Weight	1½ Pounds
Maximum Height	7¼ Inches
Maximum Diameter	2½ Inches

ELECTRICAL DATA

Filament Voltage	5.0 Volts
Filament Current	7.5 Amps
Normal Plate Dissipation	100 Watts
Maximum Average Plate Current	225 MA.
Maximum Average Grid Current	60 MA.
Maximum Plate Voltage	4000 Volts
Average Amplification Constant	25

INTERELECTRODE CAPACITANCES

Grid-Plate	2.7 Mmfd.
Grid-Filament	2.5 Mmfd.
Plate-Filament	0.4 Mmfd.

The Type 254 GAMMATRON is capable of high voltage operation, long life, unusual VHF efficiency and has the ability to stand heavy over-loads. These results are achieved by the use of a tantalum grid and plate in combination with unique Heintz and Kaufman engineering developments.

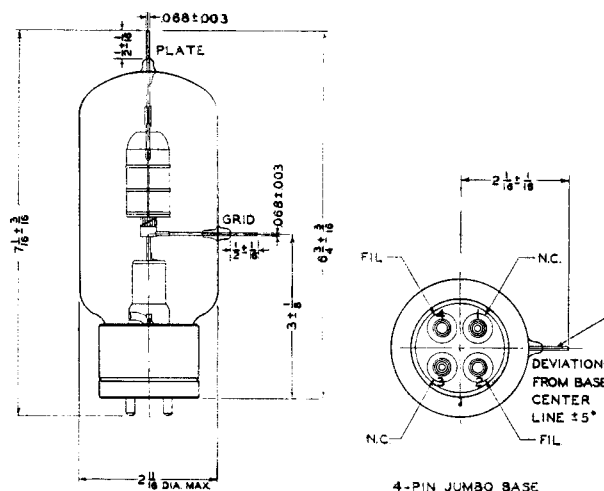
The plate and grid are mounted on short, sturdy, low resistance leads. Internal insulators are not required while perfect alignment is maintained, thus the interelectrode capacity is low and the insulation high. A plate dome confines the electron stream within the plate, eliminating destructive bombardment of the envelope and plate seal and also improving the plate efficiency. These features combine to give exceptional VHF performance.

The grid seal is protected from failure at very severe VHF loads by means of a silver film. This patented device prevents electrolytic currents from decomposing the glass at the tungsten seal, and thus grid cracks sometimes experienced in ordinary tubes are eliminated.

The use of tantalum and the elimination of unnecessary internal structures makes it possible to exhaust GAMMATRON tubes at very high temperatures. This technique completely eliminates all of the internal gas, the usual "getter" is not necessary, and the tube cannot become soft even due to heavy overloads. The ability of tantalum to reabsorb gas even though operating at high temperatures insures an excellent vacuum permanently, and long filament life.

TYPE HK 254

The information on this and the following page does not represent exact conditions of operation to be imposed for any particular situation. Because tubes are used under many widely different conditions Heintz and Kaufman will gladly furnish information for applications which differ appreciably from the illustrative examples given.



RADIO FREQUENCY POWER AMPLIFIER CLASS C UNMODULATED*

	Maximum Rating Per Tube	Typical Operation, 1 Tube			
Power Output.....	400	400	330	125	Watts
Driving Power.....	12	18	25	25	Watts
DC Plate Voltage.....	4000	4000	3000	2000	1000 Volts
DC Plate Current.....	225	125	165	215	225 ma
DC Grid Current.....	60	30	40	55	60 ma
DC Grid Voltage.....	-1000	-260	-245	-230	-195 Volts
Peak RF Grid Voltage.....		450	480	500	480 Volts
Plate Dissipation.....	100	100	100	100	80 Watts
Plate Input.....	500	500	500	430	225 Watts

*Carrier conditions for telegraphy.

RADIO FREQUENCY POWER AMPLIFIER CLASS C PLATE MODULATED*

	Maximum Rating Per Tube	Typical Operation, 1 Tube			
Power Output.....	335	335	275	115	Watts
Driving Power.....	19	23	25	23	Watts
DC Plate Voltage.....	3000	3000	2500	2000	1000 Volts
DC Plate Current.....	180	140	168	180	180 ma
DC Grid Current.....	60	35	40	45	45 ma
DC Grid Voltage.....	-800	-355	-360	-355	-315 Volts
Peak RF Grid Voltage.....		580	610	620	580 Volts
Plate Dissipation.....	85	85	85	85	65 Watts
Plate Input.....	420	420	420	360	180 Watts

*Carrier conditions for 100% modulation and 60% average value.

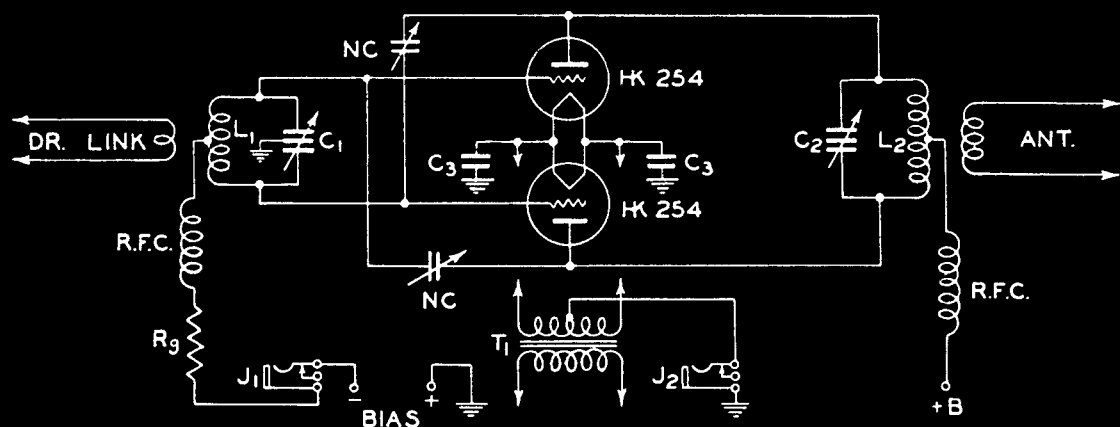
AUDIO FREQUENCY POWER AMPLIFIER CLASS B*

	Maximum Ratings Two Tubes	Typical Operation, 2 Tubes			
Power Output.....	430	420	400	280	Watts
Driving Power**.....	20	25	47	60	Watts
DC Plate Voltage.....	3000	3000	2500	2000	1000 Volts
DC Plate Current, Zero Signal.....	30	40	45	70	ma
DC Plate Current, Max. Signal.....	500	200	240	280	480 ma
DC Grid Voltage.....	-110	-80	-60	-15	Volts
Peak AF Grid to Grid Voltage.....	470	460	520	530	Volts
Plate Dissipation.....	200	170	180	160	200 Watts
Plate Input, Max. Signal.....	600	600	600	560	480 Watts
Load Resistance, Plate to Plate.....		36,400	25,200	16,400	4,000 Ohms

*All data for two tubes.

**Instantaneous power at crest of cycle: effective power is 1/2 of this value.

Gammatron Tubes



This typical final push-pull amplifier is capable of a maximum unmodulated output of 750 watts and requires a driving power of less than 50 watts. The driver stage may consist of an HK 24 or a pair of 807 tubes which may be link coupled with the grid inductance, L_1 . It is advisable to supply enough fixed bias to prevent plate current flow under static conditions (see plate curve), and the remaining bias is then developed by the grid current flow through R_g . Thus: DC grid voltage = Fixed Bias + ($R_g \times$ DC grid current).

COMPONENTS

- C_1 — Split-stator transmitting condenser, 100 mmfd. per section 0.07 inch air gap.
 C_2 — Split-stator transmitting condenser, 75 mmfd. per section 0.20 inch air gap.
 C_3 — .01 mfd. paper condenser.
N.C. — Neutralizing condensers 0.5 to 10 mmfd.
 J_1 and J_2 — Jacks to measure grid and cathode current.
 R_g — As required by operating conditions (see data).
 T_1 — 5.0 volt, 15 ampere filament transformer.

COIL DATA

Band	L_1	L_2
160 Meters	85 turns # 24 DCC Close Wound Diameter $1\frac{3}{4}$ Inches	30 Turns #12 Length $4\frac{1}{2}$ Inches Diameter 5 Inches
80 Meters	52 Turns #18 Enamel Close Wound Diameter $1\frac{3}{4}$ Inches	22 Turns #12 Length 3 Inches Diameter 5 Inches
40 Meters	30 Turns #14 Enamel Close Wound Diameter $1\frac{3}{4}$ Inches	22 Turns #12 Length $3\frac{3}{8}$ Inches Diameter $2\frac{1}{2}$ Inches
20 Meters	12 Turns #14 Enamel Length $1\frac{3}{8}$ Inches Diameter $1\frac{3}{4}$ Inches	8 Turns #12 Length $1\frac{1}{8}$ Inches Diameter $2\frac{1}{2}$ Inches
10 Meters	6 Turns #14 Enamel Length $1\frac{3}{8}$ Inches Diameter $1\frac{3}{4}$ Inches	6 Turns $\frac{1}{4}$ -Inch Copper Tubing Length 4 Inches Diameter $2\frac{1}{2}$ Inches

VERY HIGH FREQUENCY PERFORMANCE

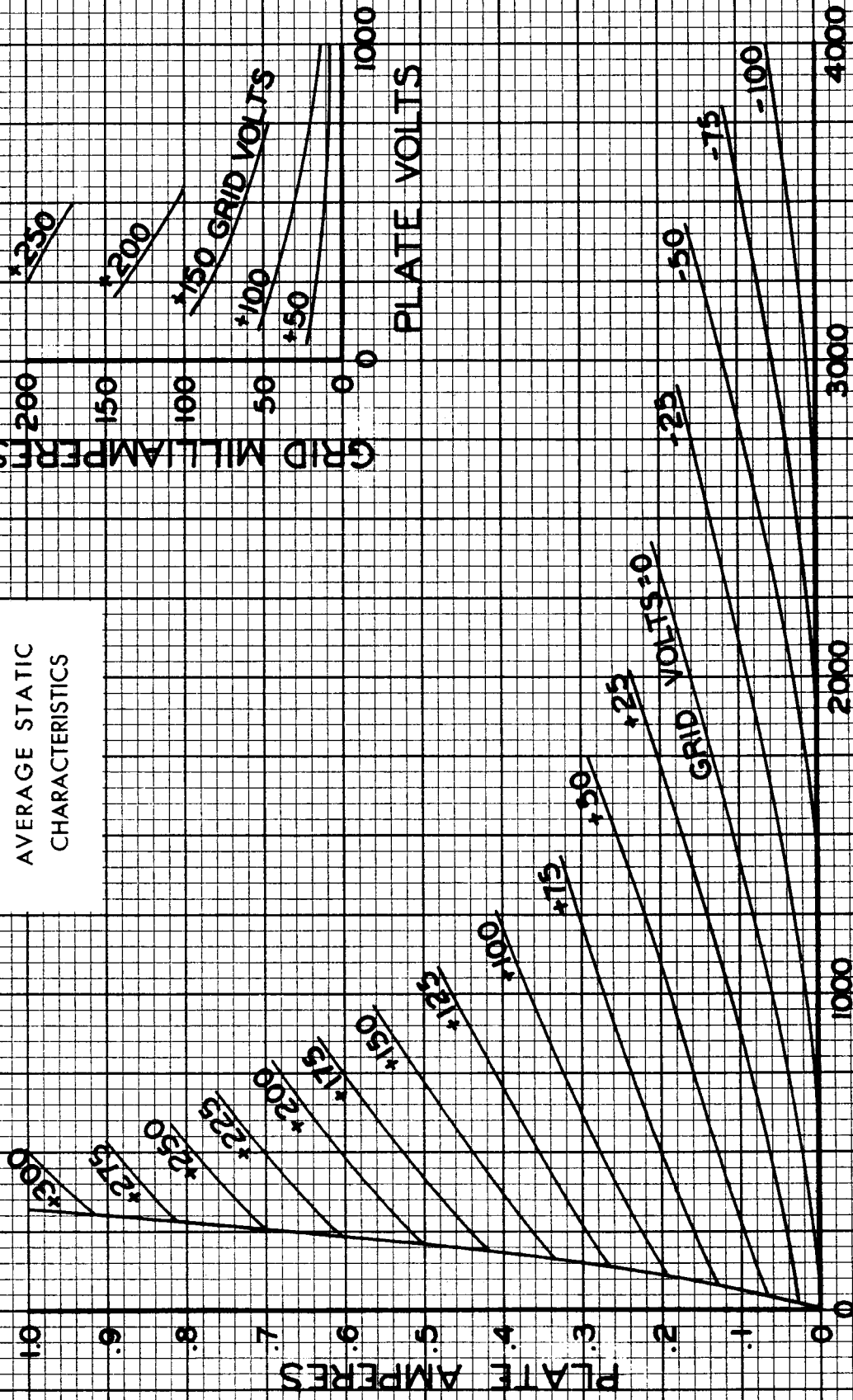
FREQUENCY	30	60	120	200 mc
Class C Unmodulated				
Max. Input	500	430	360	280 Watts
Max. Plate Volts.....	4000	3200	2700	2300 Volts
Typical Plate Efficiency.....	80	77	72	64 Percent
Class C Plate Modulated				
Max. Input	420	360	300	230 Watts
Max. Plate Volts.....	3000	2600	2200	1900 Volts

RADIO FREQUENCY DOUBLER AMPLIFIER (Feedback neutralized by conventional methods)

	Maximum Rating Per Tube	Typical Operation, 1 Tube		
Power Output.....		150	125	80 Watts
Driving Power.....		10	12	12 Watts
DC Plate Voltage.....	4000	2500	2000	1500 Volts
DC Plate Current.....	225	100	112	120 ma
DC Grid Current.....	60	10	12	12 ma
DC Grid Voltage.....	-1000	-850	-920	-900 Volts
Peak RF Grid Voltage.....		1050	1150	1125 Volts
Plate Dissipation.....	100	100	100	100 Watts
Plate Input	250	250	225	180 Watts

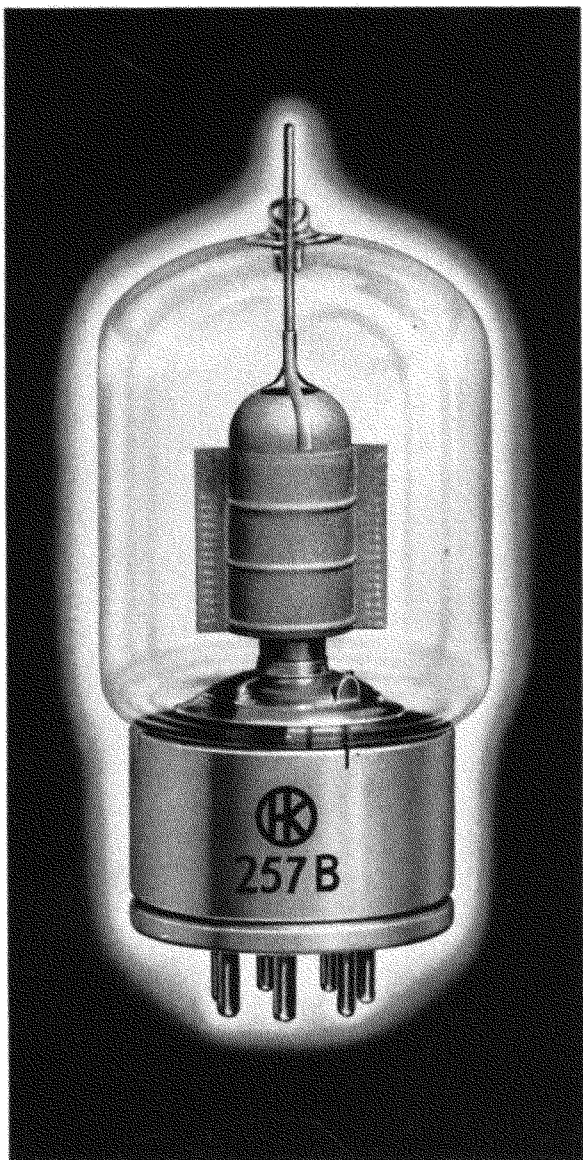
Gammatron Tubes

TYPE 254 GAMMATRON
AVERAGE STATIC
CHARACTERISTICS



GAMMATRON TYPE 257B

JAN 4E 27



BEAM PENTODE

75 watt radiation cooled beam pentode. Exceptional very high frequency performance.

ELECTRICAL DATA

Plate Dissipation	75 Watts
Maximum Screen Input	25 Watts
Filament Voltage	5.0 Volts
Filament Current	7.5 Amps.

INTERELECTRODE CAPACITIES

Plate-Grid Capacity	0.08 Mmfd.
Input Capacity	10.5 Mmfd.
Output Capacity	4.7 Mmfd.

PHYSICAL DATA

Plate	Enclosed Cylindrical Tantalum
Grids	Vertical Bar Tantalum
Filament	Thoriated Tungsten
Base	Giant 7-pin Bayonet
Envelope	Nonex Glass
Net Weight	6 Ounces
Shipping Weight	1 Pound
Maximum Height	6 $\frac{3}{16}$ Inches
Maximum Diameter	2 $\frac{1}{16}$ Inches

The type HK-257B is capable of very high frequency operation and does not require neutralization. It has very low driving power requirements, will stand high plate and screen voltages, and will stand large momentary overloads. These features are made possible through the use of tantalum plate and grid elements and an advanced design by Heintz and Kaufman Ltd. engineers. The HK-257B is the only multi-element tube in its class capable of this kind of performance.

High mutual conductance in combination with high voltage capabilities makes the grid driving power requirements of the HK-257B very low. And under many conditions the power consumed is negligible. This feature reduces the number and size of the preliminary stages required in any transmitter resulting in savings and advantages that are obvious.

The plate and grid leads are short and sturdy, resulting in low lead inductance. The suppressor grid and screen grid are each supported with two parallel leads. All four leads are terminated on the base so that they may be individually bypassed to ground. The feed back capacity is extremely low and thus it is possible to operate the HK-257B even at very high frequencies without neutralization. This feature makes the HK-257B adaptable to instant band switching circuits and such circuits may be designed with a minimum of controls.

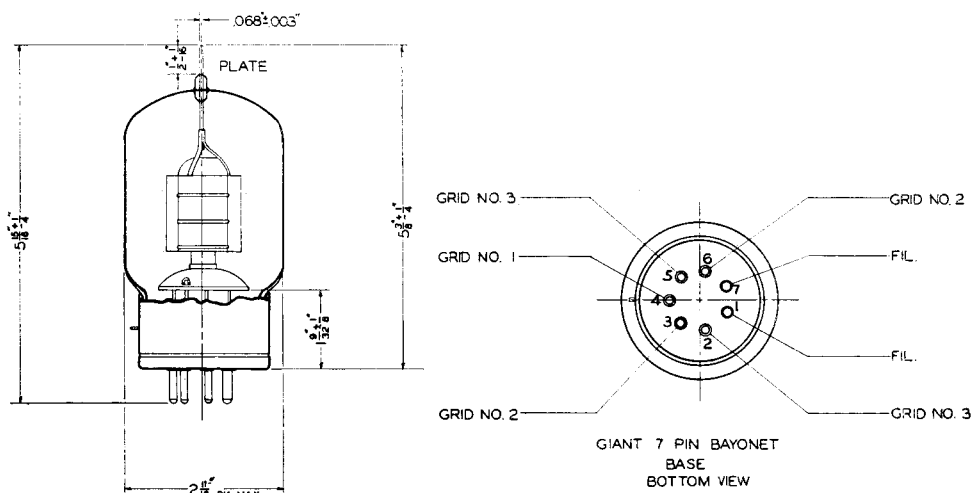
Installation into practical circuits is facilitated by the unique physical design of the HK-257B. The input and output circuits are readily isolated and complete shielding is assured when the base shell is grounded.

HEINTZ AND KAUFMAN LTD.

SOUTH SAN FRANCISCO, CALIFORNIA, U. S. A.

TYPE HK-257B

The information on this and the following page does not represent exact conditions of operation to be imposed for any particular situation. Because tubes are used under many widely different conditions Heintz and Kaufman will gladly furnish information for applications which differ appreciably from the illustrative examples given.



MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

RADIO FREQUENCY POWER AMPLIFIER— CLASS "C" UNMODULATED

	Maximum Rating Per Tube	TYPICAL OPERATION, 1 TUBE*					
Power Output	235	230	230	230	225	110	Watts
Driving Power	0	0.1	0.2	1.4	1.9	2.4	Watts
DC Plate Volts	4000	3000	2000	2000	2000	1000	Volts
DC Plate Current	150	100	150	150	150	150	M. A.
DC Suppressor Voltage	60	60	0	60	0	60	Volts
DC Suppressor Current	3	3	0	4	0	6	M. A.
DC Screen Voltage	750	750	750	500	500	400	Volts
DC Screen Current	30	8	11	11	25	20	M. A.
DC Control Grid Voltage	-500	-200	-200	-200	-200	-180	Volts
DC Control Grid Current	25	0	0.4	0.7	6	8	M. A.
Peak R.F. Control Voltage	170	215	225	255	270	270	Volts
Plate Dissipation	75	65	70	70	75	40	Watts
DC Plate Input	300	300	300	300	300	150	Watts

*Other values to obtain similar results may be used provided the maximum ratings are not exceeded.

RADIO FREQUENCY POWER AMPLIFIER— CLASS "C" PLATE MODULATED

(100% Modulation Peaks, 60% Average Value)

	Maximum Rating Per Tube	TYPICAL CARRIER CONDITIONS, 1 TUBE					
Power Output	200	195	145	143	95	Watts	
Driving Power	0.1	0.2	0.4	1.7	1.7	Watts	
DC Plate Volts	3000	2500	2000	1500	1000	Volts	
DC Plate Current	135	100	125	135	135	M. A.	
DC Suppressor Volts	60	60	60	60	60	Volts	
DC Suppressor Current	3	3	3	4	5	M. A.	
DC Screen Volts	600	600	600	400	400	Volts	
DC Screen Current	30	8	10	11	13	M. A.	
DC Control Grid Volts	-500	-200	-200	-200	-130	-130	Volts
DC Control Grid Current	25	0.6	1.0	1.4	8	8	M. A.
Peak R.F. Control Voltage	220	235	255	235	235	Volts	
Plate Dissipation	65	50	55	57	59	40	Watts
DC Plate Input	250	250	250	202	202	135	Watts

Gammatron Tubes

RADIO FREQUENCY DOUBLER AMPLIFIER

MAXIMUM INPUT 200 WATTS

	Maximum Rating Per Tube	TYPICAL OPERATION, 1 TUBE			
Power Output		120	110	110	80 Watts
Driving Power		0	0.2	1.8	5.5 Watts
DC Plate Voltage	4000	2000	1500	1500	1000 Volts
DC Plate Current	150	95	120	120	150 M. A.
DC Suppressor Voltage		60	60	60	60 Volts
DC Suppressor Current		2	3	4	6 M. A.
DC Screen Voltage	750	750	750	500	500 Volts
DC Screen Current	30	10	15	13	25 M. A.
DC Control Grid Voltage	-500	-400	-400	-330	-400 Volts
DC Control Grid Current	25	0	0.5	5	12 M. A.
Peak R.F. Control Voltage		400	425	400	510 Volts
Plate Dissipation	75	70	70	70	70 Watts
DC Plate Input	200	190	180	180	150 Watts

CLASS "A" AMPLIFIER—AUDIO AND TELEVISION

	2 Tubes Overbiased	1 TUBE OPERATION	
Power Output	315	30	25 Watts
DC Plate Voltage	1500	1000	500 Volts
DC Plate Current Zero Signal	80	75	150 M. A.
DC Plate Current Max. Signal	292		M. A.
DC Screen Voltage	750	300	500 Volts
DC Screen Current Zero Signal	2	5	10 M. A.
DC Screen Current Max. Signal	38		M. A.
DC Suppressor Voltage	60	0	0 Volts
DC Control Grid Voltage (Approx.)	-125	-27	-36 Volts
Peak Audio Voltage	240	27	36 Volts
Plate Input Max. Signal	438		Watts
Plate Dissipation Max.	150	75	75 Watts
Load Resistance		12,000	2600
Load Resistance, Plate to Plate	12,000		Ohms

RADIO FREQUENCY POWER AMPLIFIER— CLASS "C" SUPPRESSOR GRID MODULATED

(Maximum Input 110 Watts)

	Maximum Rating Per Tube	TYPICAL CARRIER CONDITIONS, 1 TUBE		
Power Output		35	33	32 Watts
Driving Power		.4	1.4	2.0 Watts
Audio Power		100*	100*	500† Milliwatts
DC Plate Voltage	2000	2000	1500	1000 Volts
DC Plate Current	100	55	70	90 M. A.
DC Suppressor Voltage	-500	-300	-210	-135 Volts
Peak Suppressor Current		0	0	3 M. A.
DC Screen Voltage‡	600	500	500	600 Volts
DC Screen Current		27	44	41 M. A.
Screen Resistor		2000	2000	5000 Ohms
DC Control Grid Voltage	-500	-130	-130	-130 Volts
DC Control Grid Current	25	3	8	11 M. A.
Peak R.F. Driving Voltage		150	195	200 Volts
Peak A.F. Modulating Voltage		300	210	175 Volts
Plate Dissipation	75	75	72	60 Watts

*Use Type 6C5 tube or equal with 1:2 step-up transformer ratio.

†Use receiving type pentode as 6F6 and 1:1 transformer ratio.

‡Source voltage. Apply through indicated resistor.

Gammatron Tubes

TYPE 257B BEAM PENTODE OPERATING NOTES

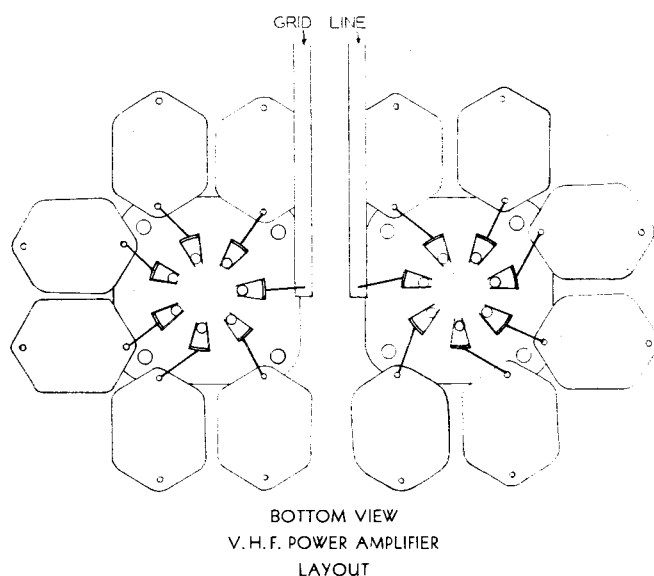
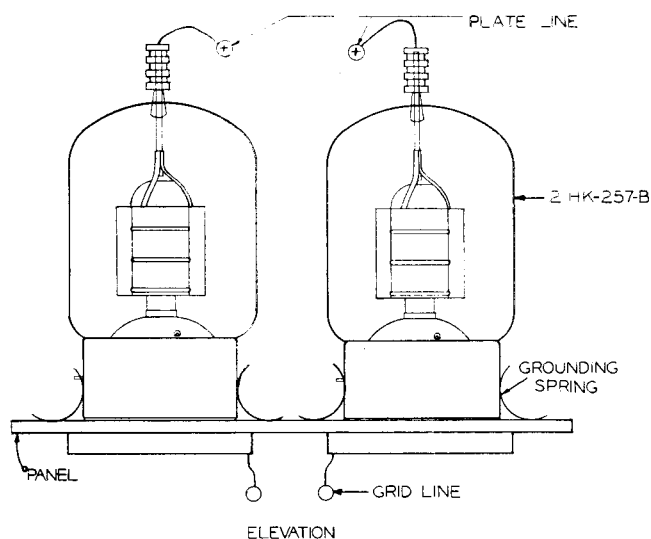
1. Protect your investment: Always provide sufficient fixed bias or cathode bias to limit the plate current to a safe value. Plate current depends on the screen voltage, not the plate voltage. The tube may be easily damaged by loss of bias because at zero bias the plate current is great with proper screen voltage. Apply reduced plate and screen voltages when tuning up transmitter.
2. The 257B has a very high transconductance and hence extreme care must be taken to prevent self-oscillation. The output and input circuits must be completely separated. Parasitic suppressors are often helpful. Screen and suppressor leads should be by-passed directly at the socket. For operation on high frequencies both parallel screen and suppressor leads should be by-passed to the filament. Because the internal screening shield is inside the metallic base shell, it is only necessary to provide spring contacts grounding the base shell to the panel to complete the shielding.
3. In employing various combinations of plate and screen voltages, the following general rules will be helpful:
 - (1) Driving requirements and screen current are lower with high screen voltage.
 - (2) Driving requirements are lower and screen current is decreased with approximately 60 volts applied to the suppressor.
 - (3) For the majority of applications zero suppressor voltage will be satisfactory.
4. Apply screen voltage or excitation after plate voltage or at the same time, not before. Remove screen voltage or excitation before plate voltage or at same time.
5. In tuning the tank coil to resonance there may be little change in plate current when the amplifier is loaded. Use the tantalum plate as a resonance indicator. Minimum plate temperature indicates resonance.

VERY HIGH FREQUENCY RATINGS

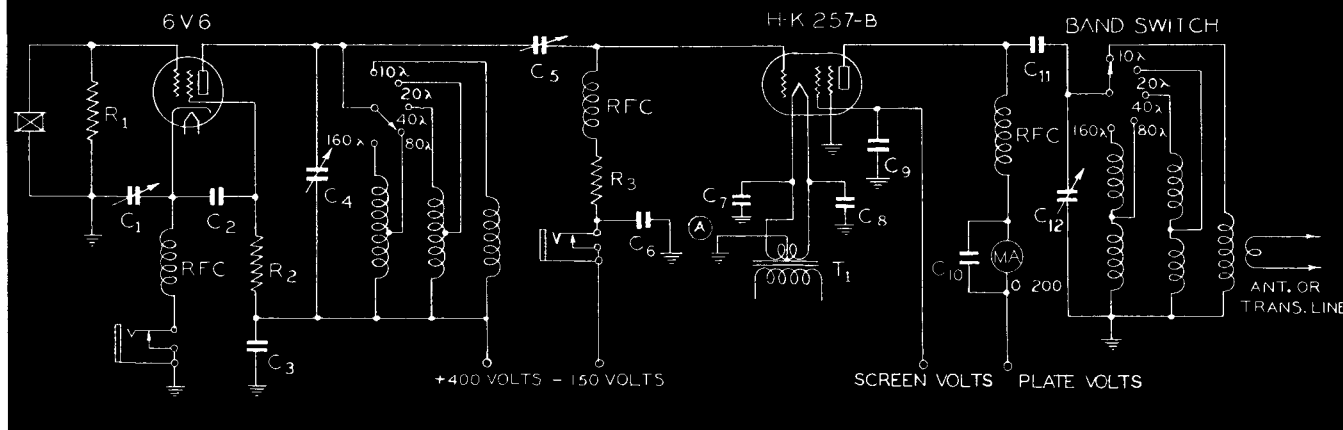
Percentage maximum plate voltage and input power based on low frequency ratings shown on previous page.

Frequency	75	120	150 Mc.
Class "B" or Grid			
Modulated R. F. P. A.....	100%	90%	80%
Class "C" R. F. P. A.			
Telegraph or Telephone.....	100%	75%	50%

VHF POWER AMPLIFIER LAYOUT



Gammatron Tubes



HK-257B ALL-BAND TRANSMITTER

The Type 257B beam pentode is particularly adapted for an all-band radio transmitter, since it requires extremely low driving power and does not require neutralization. Such a transmitter is shown in the above wiring diagram. It is capable of operation in all of the amateur bands from 10 to 160 meters. It incorporates band switching in the crystal oscillator and radio frequency amplifier circuit. Any of the low power all-band coil assemblies may be employed in the oscillator plate circuit.

The Type 257B beam pentode requires only a small amount of radio frequency excitation and hence a single 6V6 metal tube in the oscillator circuit will drive the radio frequency amplifier to its full output. The careful internal shielding of the 257B provides that no neutralization is necessary.

The 257B has a tantalum plate which makes an excellent tuning indicator. Since maximum antenna output always occurs at the point of minimum plate color, this form of tuning is more convenient and more accurate than the indication of a milliammeter in the plate or cathode circuit. The current dip is rather small at the point of resonance in a pentode tube when proper load is coupled into the tank circuit.

MODULATION

If desired, this radio frequency unit may be adapted to telephone purposes by applying a number of forms of modulation. The tube may be plate modulated, suppressor grid modulated, or cathode modulated in accordance with the particular requirements.

CRYSTAL OSCILLATOR

The Type 6V6 oscillator employs a radio frequency choke in its cathode circuit, together with an adjustable condenser for controlling the amount of regeneration in this circuit. This condenser must be set to a value that allows the plate circuit to be tuned to the second harmonic of 80 and 160 meter crystals. For 10 and 20 meter operation, crystals of these respective frequencies should be employed. A cathode regenerative circuit is a distinct aid in obtaining good output from 10 to 20 meter crystals.

In employing standard band switching coil units with the oscillator, it will probably be necessary to remove a few turns from the 10 meter coil in order to resonate the circuit over the entire band.

COIL DATA

The final tank coils are wound on ceramic forms. A ten meter coil has $4\frac{1}{2}$ turns of #10 wire wound on a $1\frac{1}{8}$ " ceramic form. The length of the winding is approximately

$1\frac{1}{4}$ ". The 20 and 40 meter coils are wound on $2\frac{1}{2}$ " diameter ceramic forms. Five turns for the 20 meter coil and nine additional turns for the 40 meter coil. The nine turn winding is spaced approximately 1" from the five turn winding and the two windings are connected in series to give a coil of 14 turns to the 40 meter operation. The 80 and 160 meter coils are wound in a similar manner on a 3" diameter ceramic form. The 80 meter section of the coil has $12\frac{1}{2}$ turns and the 160 meter has a total of $28\frac{1}{2}$ turns. A ribbed coil form may be employed such that approximately 7 turns per inch of #12 enameled wire may be employed. The 20 and 40 meter coil is wound of the same size wire employing six turns per inch. All of these coils should be grouped around the Type 257B pentode with the high frequency coil mounted close to the Band Switch. If operation on 160 meters is not contemplated, a final tank condenser of approximately 100 to 125 micro-microfarads should be employed in place of the 250 micro-microfarad unit.

OPERATION

Antenna may be coupled to the tuned plate circuit by link coupling to the external tuned antenna circuit or by inductive coupling with a few turns in wire wound directly over the coil form. The Type 257B will require a plate voltage of 1500 to 2000 volts, while 400 volts should be supplied for the Type 6V6 tube and this voltage may be also applied to the screen of the Type 257B beam pentode.

Since the tuning of the Type 257B beam pentode is somewhat unconventional compared to that of a neutralized triode amplifier, it is desirable to provide some means of indicating the amount of antenna or feeder current at all times, although the degree of plate color and amount of input to the tube always gives a good indication of the operating efficiency.

COMPONENTS

- R₁—100,000 Ohm, 1 Watt resistor.
- R₂—15,000 Ohm, 10 Watt resistor.
- R₃—5,000 Ohm, 10 Watt resistor.
- C₁—350 mmf. variable mica condenser.
- C₂—.005 mf. 500 Volt condenser.
- C₃—.01 mf. 500 Volt condenser.
- C₄—140 mmf. variable air condenser.
- C₅—100 mmf. variable air condenser.
- C₆—1.0 mf. paper condenser.
- C₇, C₈—.003 mf. mica condenser.
- C₉—.01 mf. 1000 Volt mica condenser.
- C₁₀—.01 mf. mica condenser.
- C₁₁—.002 mf. 5000 Volt mica condenser.
- C₁₂—250 mmf. 3000 Volt variable air condenser.
- T₁—5.0 Volt 7.5 Amp. filament transformer.

Gammatron Tubes

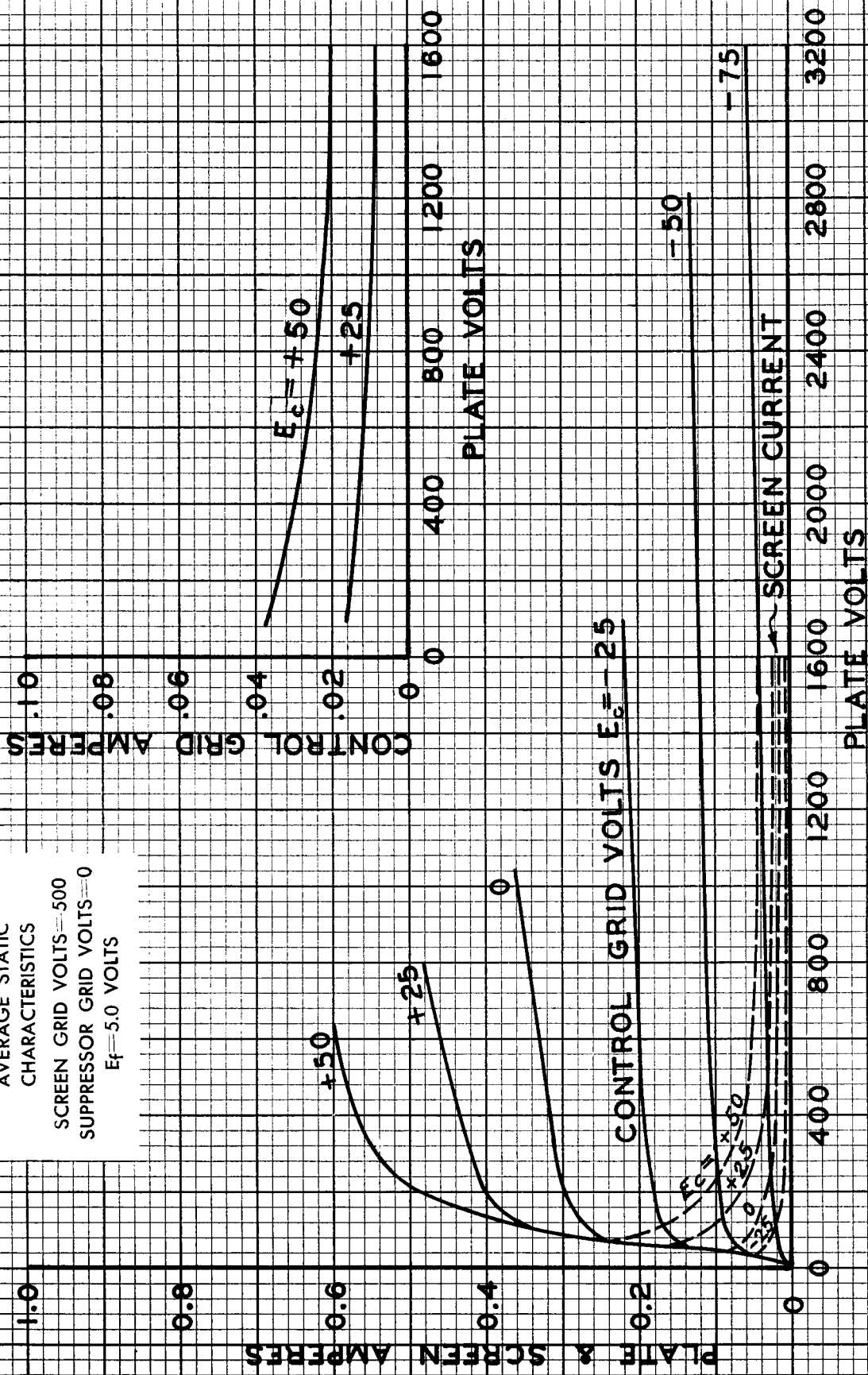
TYPE 257B GAMMATRON

AVERAGE STATIC
CHARACTERISTICS

SCREEN GRID VOLTS = 500

SUPPRESSOR GRID VOLTS = 0

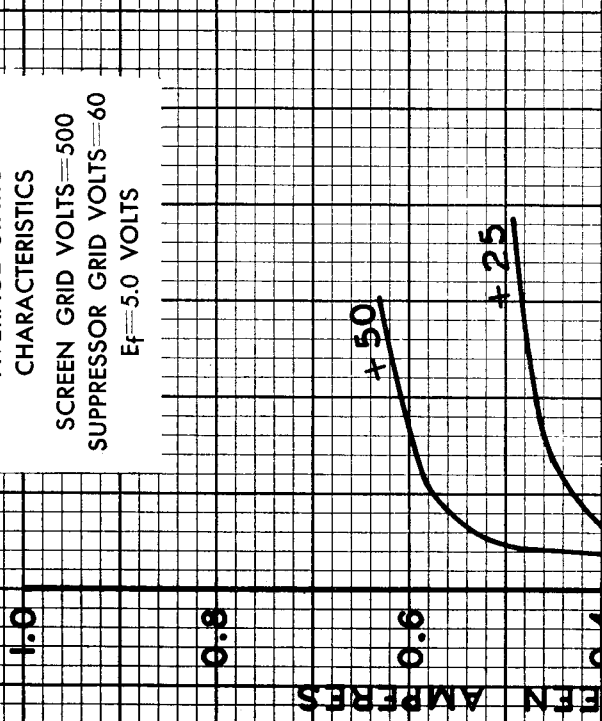
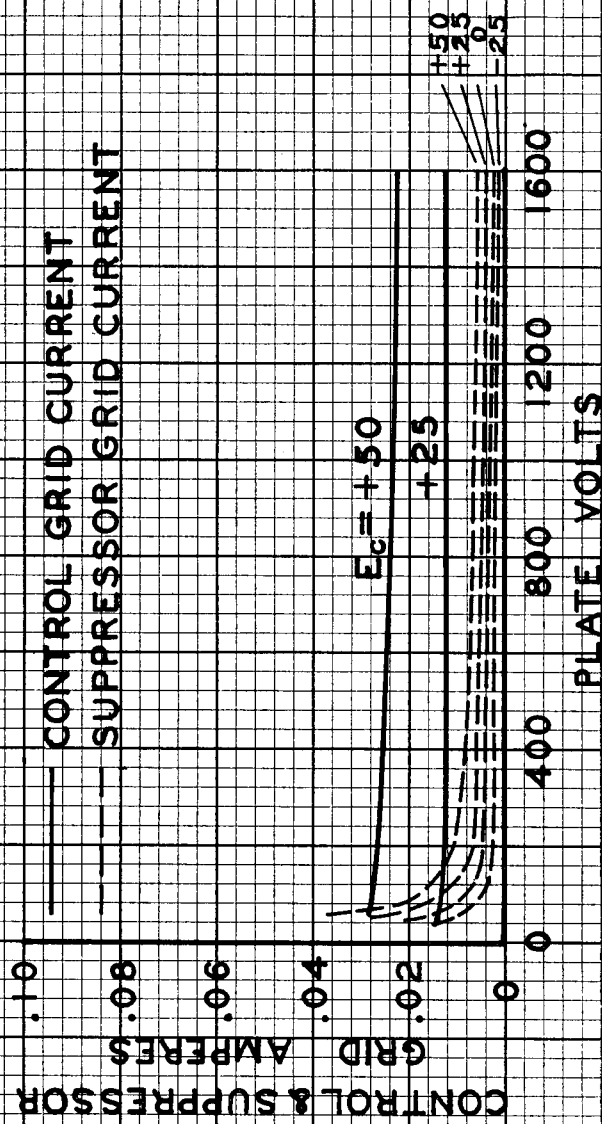
$E_f = 5.0$ VOLTS



TYPE 257B GAMMATRON

AVERAGE STATIC CHARACTERISTICS

SCREEN GRID VOLTS = 500
SUPPRESSOR GRID VOLTS = 60
 $E_f = 5.0$ VOLTS



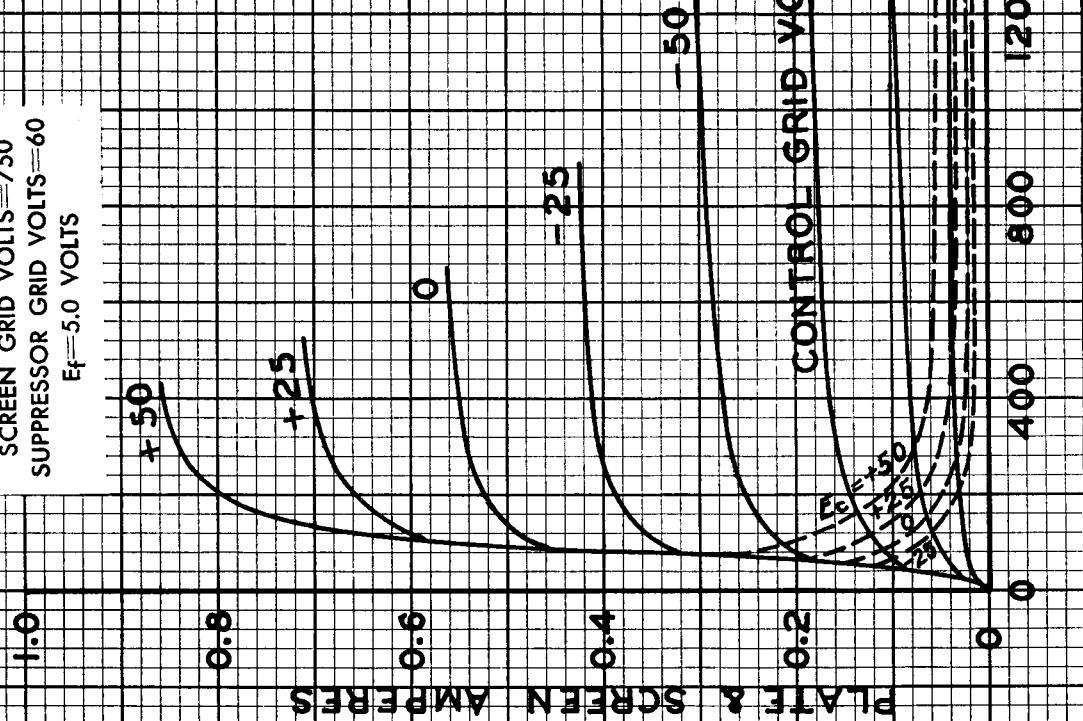
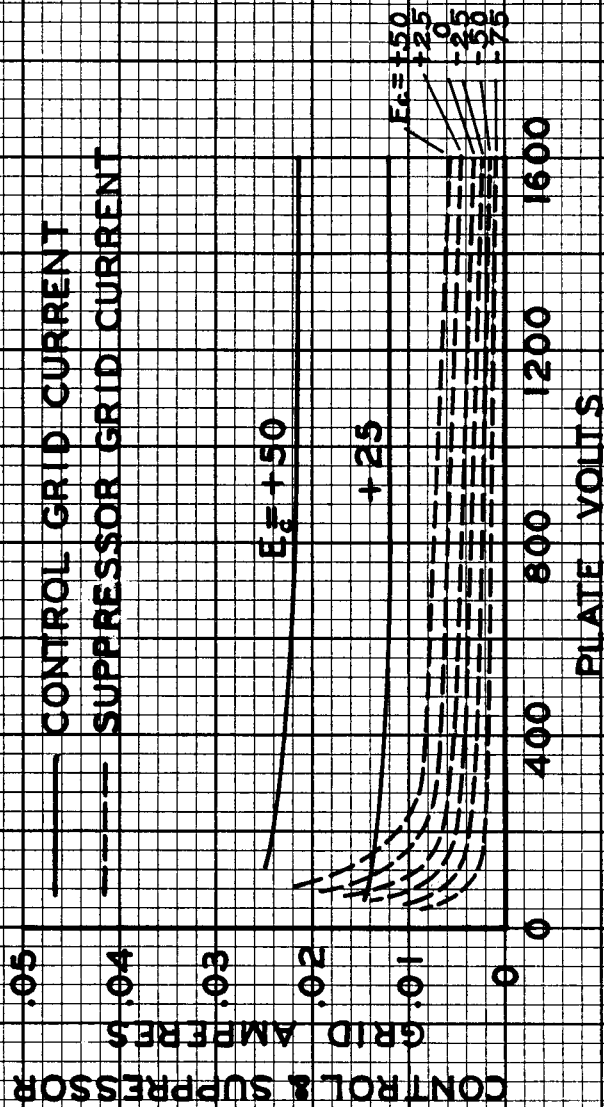
TYPE 257B GAMMATRON

AVERAGE STATIC
CHARACTERISTICS

SCREEN GRID VOLTS=750

SUPPRESSOR GRID VOLTS=60

$E_f = 5.0$ VOLTS



GAMMATRON

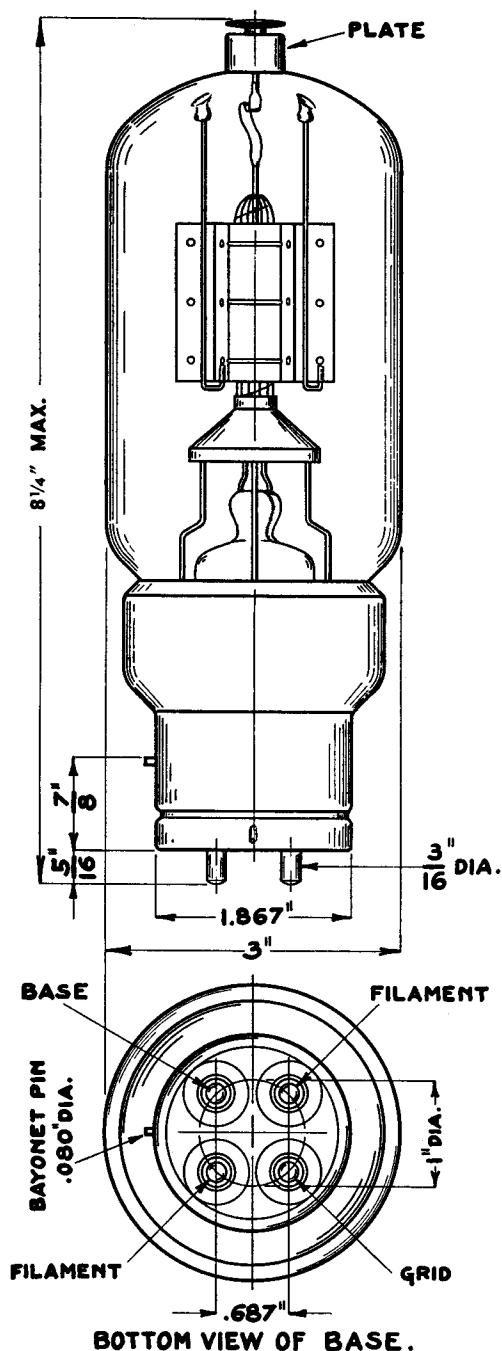
**TYPE
HK-354**

PHYSICAL DATA

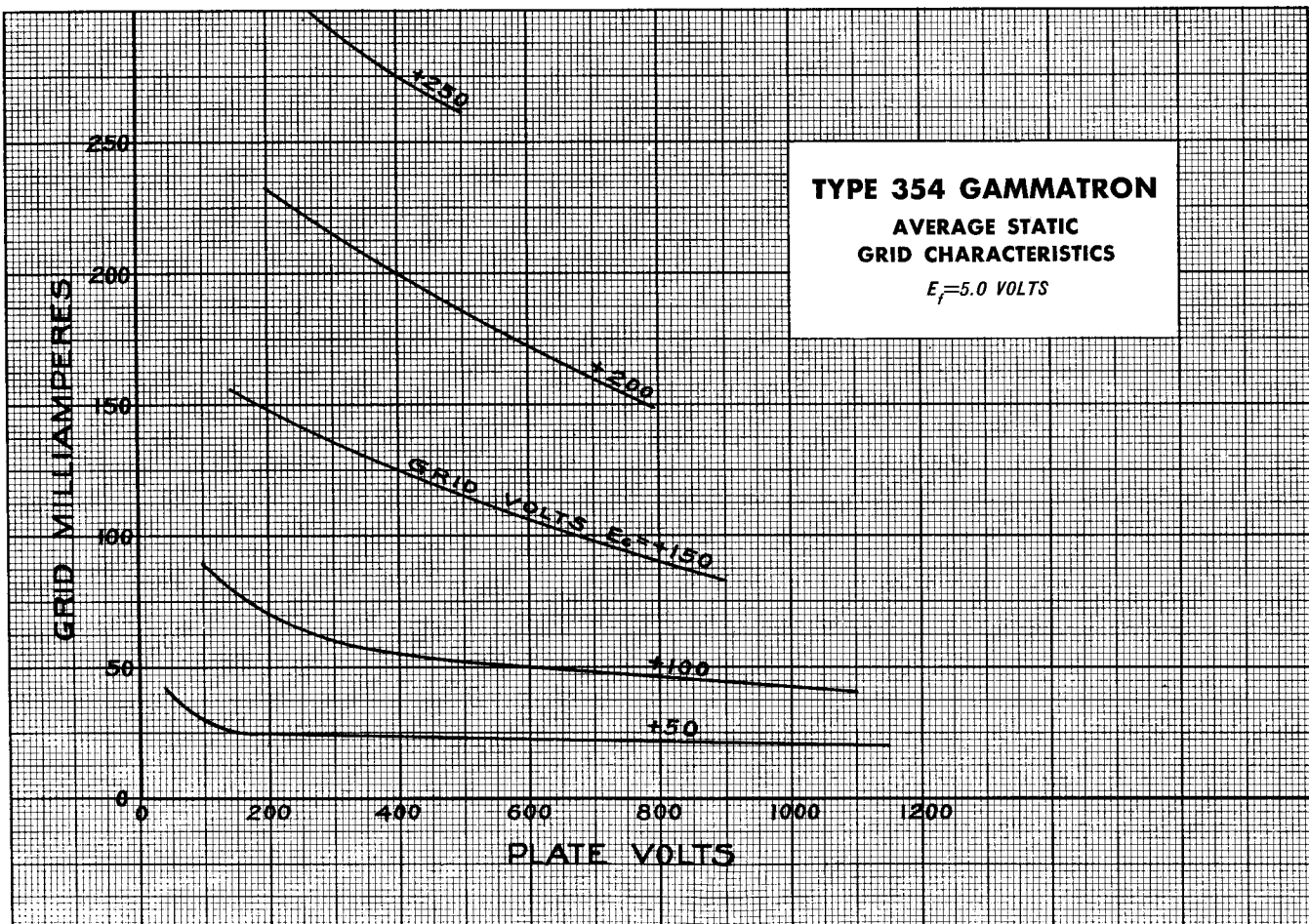
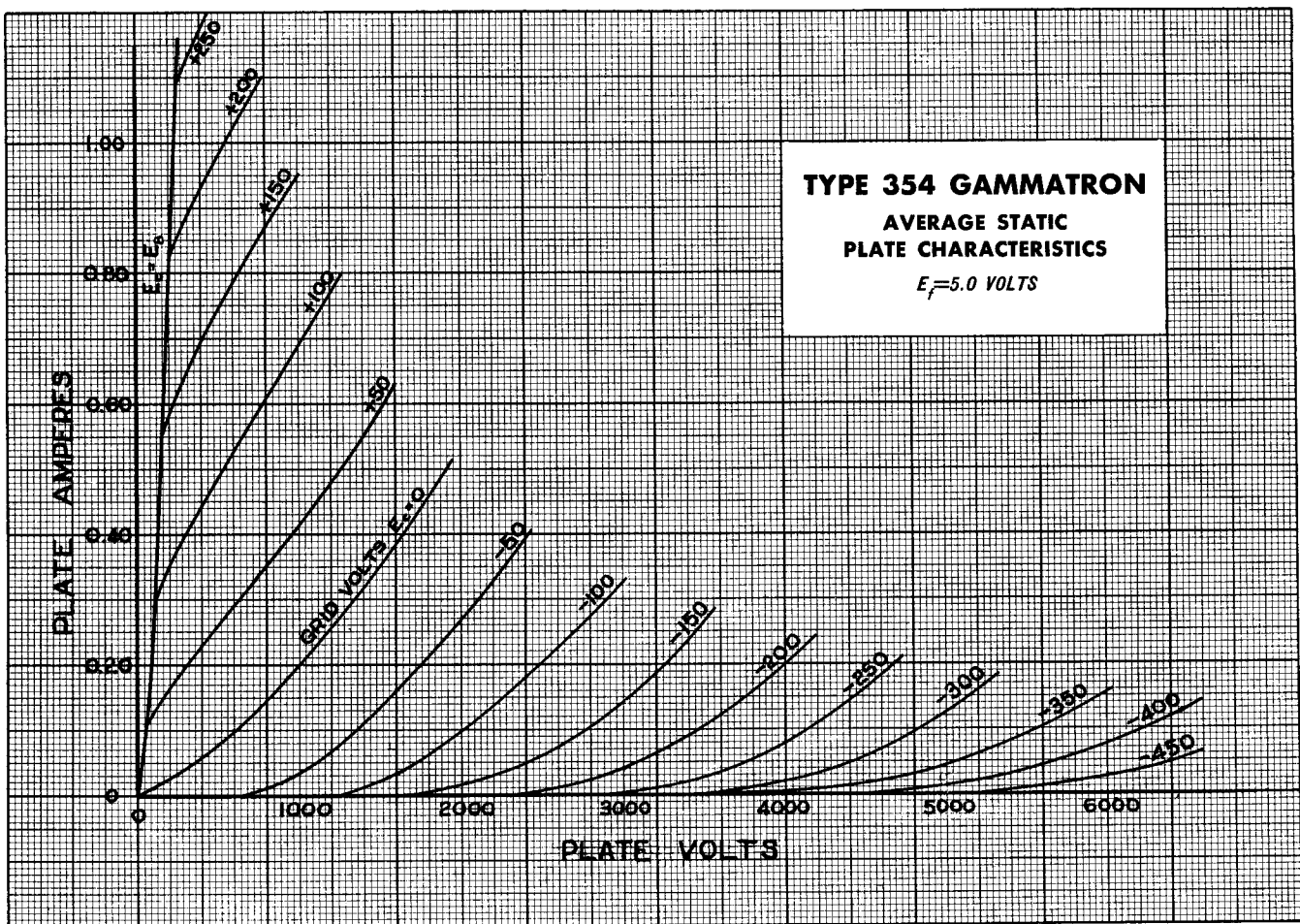
Plate	Cylindrical Tantalum
Grid	Braced Vertical Bar Tantalum
Filament	Thoriated Tungsten
Blank	Nonex Glass
Base	Standard Fifty Watt
Base Insulator	Ceramic
Net Weight	6½ Ounces
Shipping Weight	4 Pounds
Maximum Height	8¼ Inches
Maximum Diameter	3 Inches

ELECTRICAL DATA

Filament Voltage	5.0 Volts
Filament Current	10 Amps.
Normal Plate Dissipation . . .	150 Watts
Maximum Average Plate Current .	0.3 Amps.
Maximum Plate Voltage . . .	4000 Volts
Maximum Average Grid Current .	0.05 Amps.
Average Plate Impedance . . .	2800 Ohms.
Average Amplification Constant .	14.
Grid-Plate Capacitance	4. mmfd.
Grid-Filament Capacitance . . .	9. mmfd.
Plate-Filament Capacitance . . .	0.4 mmfd.



GAMMATRONS HAVE TANTALUM PLATES and GRIDS!



TYPE HK-354

APPLICATION AS A RADIO FREQUENCY AMPLIFIER

RADIO FREQUENCY AMPLIFIER – CLASS “C” (TELEGRAPHY)

(See Page 154-3)

The **Type HK-354 GAMMATRON** may be used as a Class C radio frequency amplifier with exceptionally good results. High mutual conductance, low internal capacitance, and the ability to stand high plate voltages make it possible to operate the **Type HK-354 GAMMATRON** at high efficiencies with low power excitation.

A Class C amplifier operates at a bias greater than cut off. The plate current flows in pulses less than one-half cycle during the period of positive grid swing when the plate impedance is low. The shorter the duration of the plate current pulse the higher the efficiency becomes, but the power output becomes less. High efficiency requires a large bias with a resultant increase in excitation power. Normal operation results in a compromise between the factors of power output, efficiency and excitation power. Table VI gives the operating data at the point of best compromise for various plate voltages.

The amount of excitation power required is governed by the output power desired and the operating efficiency. The **Type HK-354 GAMMATRON** is unusually easy to drive as may be seen by examination of the operating data. Using less driving power will merely reduce the output power and lower the efficiency slightly.

Grid leak bias may be used, but it is wise to provide enough fixed bias in addition to prevent the tube from becoming injured in the event of an excitation failure. The amount of protective fixed bias required is small, and it is well worth the insurance that it provides against tube injury. Its importance cannot be over-emphasized when plate potentials in excess of 1000 volts are used. The resultant bias is the fixed bias plus the product of the grid leak resistance multi-

plied by the rectified D.C. current. The correct value of the grid leak resistor (usually between 5,000 and 20,000 ohms) is readily determined by experiment. It should never be necessary to run the grid current above 50 milliamperes in order to properly excite a **Type HK-354 GAMMATRON**.

The output can be estimated with reasonable accuracy as the difference between input power and actual plate dissipation, bearing in mind that 75 watts plate dissipation causes a perceptible plate glow, 100 watts a dull red, and 150 watts a medium red. Actual efficiency is the ratio of output power to input power. In order to obtain relatively high efficiencies it is essential to use a tank circuit of low loss and a high L/C ratio.

Table I shown below, has been computed for an average tube, and individual tubes may vary somewhat from these values. This data applies only to operation at frequencies below 15 megacycles. When operating at ultra high frequencies it will be necessary to reduce these ratings. Limiting factors become plate, grid and glass bulb temperatures, and R. F. grid and plate current.

For details of design and adjustment of a Class C amplifier refer to current radio magazines.

CLASS “C” (TELEPHONY)

For Class C amplifier radio telephone operation it is not advisable to work the **Type HK-354 GAMMATRON** as hard, because it is necessary to provide for the peak output. For high-quality phone transmission the importance of adequate shielding and complete neutralization cannot be over-stressed. Link coupling between the buffer and amplifier is highly recommended.

The conditions for bias, maximum rating, and adjustment are about the same as in the case above. They may be determined by inspection of Table I.

RADIO FREQUENCY AMPLIFIER—CLASS “C” (SINGLE TUBE)

TABLE I

Plate Supply Volts	Plate Milli-amperes	Grid Bias Volts	Grid Milli-amperes	Effective Excitation Volts	Driving Power Watts	Power Input Watts	Load Resistance Ohms	Power Output Watts	Plate Loss Watts	Plate Efficiency Per Cent
1500	250	–300	50	390	28	375	2800	270	105	72
2000	255	–400	50	466	32	510	3900	388	122	76
2500	255	–475	50	526	36	638	5000	504	134	79
3000 ₁	255	–550	50	582	40	765	5900	628	137	82
3500	255	–625	50	642	43	890	7000	740	150	83
4000 ₂	245	–700	48	700	46	980	8200	840	140	84

₁Maximum rated plate voltage for modulated amplifier.

₂Maximum rated plate voltage for c.w. telegraph.

GAMMATRONS HAVE TANTALUM PLATES and GRIDS!

RADIO FREQUENCY AMPLIFIER ---CLASS "B" LINEAR

The efficiency of a Class "B" amplifier is about one-half of a Class C amplifier and consequently its power output is much less. However, a Class B amplifier is attractive because it is a linear amplifier—the output signal is directly proportional to the input signal. It is possible then to modulate at low power requiring a small inexpensive modulation system, and amplify the modulated carrier. Another convenient method is to use grid modulation requiring only a few watts of audio power. The load impedance in a radio frequency amplifier is a resonant circuit, hence either a single tube or two tubes in push-pull may be employed. The Type HK-354 GAMMATRON performs excellently in Class B circuits.

Since the power required at peak modulation (100% modulation) is four times the carrier power, the tube must be operated at about one-fourth full power output and about one-half normal efficiency.

To obtain satisfactory operation of a Class B circuit, consistent with good output and low distortion, careful adjustment is required. First, the neutralization must be complete. With a high load impedance (loose coupling to the load) and bias adjusted to cut off, increase the excitation, fully modulated, until a grid meter indicates current is being taken by the grid (about 10 milliamperes). Then with the carrier unmodulated decrease the load impedance (increase the load coupling) until a maximum power output is obtained or until the plate loss becomes the rated value.

The grid modulated amplifier closely resembles a Class B amplifier, and its power outputs are similar. The adjustment is somewhat critical, however, but with proper adjustment good performance can be expected.

RADIO FREQUENCY AMPLIFIER CLASS "B"---CLASS "B" CARRIER WITH 100% MODULATION

TABLE II
(SINGLE TUBE)

Plate Supply Volts	No-signal, Plate Milliamps	Plate Current Milliamps	Grid Bias Volts	Carrier Excitation Peak Volts	Peak Driving ₂ Power Watts	Load Resistance Ohms	Carrier Output Watts	Plate Loss Watts	Plate Efficiency Per Cent
1000	20	58	- 60	85	8	5000	20	38	35
1500	30	81	- 95	110	10	5000	39	83	32
2000	50	97	-125	125	10	5000	60	134	31
2500	40	88	-165	140	10	7500	72	148	33
3000	33	78	-205	158	10	11000	82	153	35

Arithmetic sum of 2nd, 3rd, and 4th harmonics of modulated wave are not greater than 3.5% at 100% modulation, and under 2.5% at 75% modulation.

₁Lower no-signal plate currents will increase distortion.

₂At crest of audio cycle with 100% modulation.

RADIO FREQUENCY AMPLIFIER---GRID MODULATED

The audio system required for grid modulating the Type HK-354 GAMMATRON is very economical, the audio power required being negligible.

The audio power required is of the order of seven to ten watts. The radio frequency power available should be fifteen to twenty watts, assuming that the r.f. input circuit is loaded using non-inductive resistor absorbing one-half to two-thirds of the excitation power. This circuit loading assists in securing the required regulation for high quality.

Referring to the above table one should use 1.5 to 2.0 times the grid bias given for Class B linear operation. Load resistance is practically the same and carrier output almost as high as that listed above in Table II.

To improve the linearity and efficiency of a grid modulated amplifier a cathode resistor is sometimes used in combination with fixed bias. Methods of this order have been discussed in various radio publications and the reader is referred to the same.

GAMMATRONS HAVE TANTALUM PLATES and GRIDS!

TYPE HK-354

APPLICATIONS AS AN AUDIO AMPLIFIER

Audio Amplifier—Class "A"

The Type HK-354 GAMMATRON is an excellent power audio amplifier since it has a low plate resistance and will stand a high plate potential. At the same time it has a relatively high amplification factor thus requiring a small bias, and only a small signal voltage need be applied to the grid to develop full power output.

Under ordinary circumstances the optimum load resistance of a Class A triode power amplifier is equal to twice the dynamic plate resistance. This is also true of larger power tubes as long as the plate dissipation does not become a limiting factor. At plate potentials over 1500 volts the HK-354 GAMMATRON Class A operation is limited by plate dissipation. Hence, at these values it is necessary to adjust the grid bias to limit the plate dissipation to 150 watts, and use a higher load resistance. The plate dissipation is the D.C. plate voltage multiplied by the D.C. plate current with no audio signal input. Since individual tubes will vary somewhat as to amplification factor, the controlling element in adjusting an HK-354 GAMMATRON as a Class A audio amplifier is the plate current. Always adjust the plate current to the value indicated in the tables below, using the bias required for that adjustment. There is little

advantage in employing plate potentials of more than 2500 volts. Actual plate dissipation may be estimated from the plate glow, 75 watts giving just a perceptible glow, 100 watts a dull red, and 150 watts a medium red.

Below is shown the typical operating data for the HK-354 GAMMATRON. The data is divided into three tables for convenience. Table III gives the performance limiting the second harmonic distortion to five per cent. Table IV gives the performance limiting the second harmonic distortion to ten per cent. Table V gives the performance for two tubes operating in push-pull. All quantities in Table V refer to two tubes. It will be noted that the output power in this connection is higher than two single tubes. Moreover, the distortion is less because of the cancellation of second order harmonics.

These power outputs are computed assuming that the grid is driven to zero. If the plate current is much greater than normal when the proper bias is applied, it is often an indication that the tube is oscillating or that it is picking up radio frequency voltage from some other circuit. An inductive grid leak often aggravates this condition.

CLASS "A" AUDIO AMPLIFIER PERFORMANCE

TABLE III

(SINGLE TUBE)

Plate Supply Volts	Plate Milli-amperes	Grid Bias Volts	Plate Input Watts	Load Resistance Ohms	Power Output Watts	Plate Efficiency Per Cent	Per Cent Second Harmonic
1000	60	- 40	60	10,000	6	11	3
1500	100	- 60	150	10,000	16	11	4
2000	75	-110	150	20,000	32	21	5
2500	60	-150	150	30,000	40	27	5

TABLE IV

(SINGLE TUBE)

Plate Supply Volts	Plate Milli-amperes	Grid Bias Volts	Plate Input Watts	Load Resistance Ohms	Power Output Watts	Plate Efficiency Per Cent	Per Cent Second Harmonic
1000	57	- 42	57	10,000	7	12	10
1500	90	- 65	135	10,000	18	13	10
2000	75	-110	150	15,000	36	24	10
2500	60	-150	150	25,000	44	29	10

CLASS "A" AUDIO PUSH-PULL AMPLIFIER PERFORMANCE

TABLE V

(TWO TUBES)

Plate Supply Volts	Plate Milli-amperes	Grid Bias Volts	Plate Input Watts	Plate-to-Plate Load Ohms	Power Output Watts	Plate Efficiency Per Cent	Per Cent Third Harmonic
1000	100	- 45	100	16,000	16	16	3
1500	180	- 65	270	16,000	43	16	3
2000	150	-110	300	20,000	82	27	3
2500	120	-150	300	40,000	96	32	4

GAMMATRONS HAVE TANTALUM PLATES and GRIDS!

AUDIO AMPLIFIER—CLASS "B" MODULATOR

Where outputs in excess of the capacity of two Type HK-354 GAMMATRONS in Class A are required, for modulation or high power audio work, it is desirable to use two HK-354's in Class B. In this connection efficiencies of more than twice those in Class A can be obtained. Operated in this manner only one tube works at a time. One tube operates during half of the cycle while the other is idle, and during the remaining half cycle the situation is reversed.

The Type HK-354 GAMMATRON is particularly adapted to Class B work since it will stand a high plate potential, has a low plate resistance and has a relatively high amplification factor. Thus, it has a large power output, and is an easy tube to drive.

To get any reasonable amount of power out of a Class B amplifier it is necessary to drive the grids positive. This means that the driving tubes must supply power at the peak of the grid swing. The driver must have sufficient capacity to supply the peak power without appreciable drop in excitation voltage. This requires a low impedance driver circuit if distortion is to be avoided.

Since only one tube works at a time, the plate-to-plate load resistance (indicated below) is four times

the single plate load resistance. Frequently, it is convenient in considering impedance relations to match the secondary impedance to one-half of the primary using the single plate load value. There is always the possibility that a high power Class B stage will oscillate. Such a condition is indicated when the amplifier draws considerable plate current even though the correct bias is used, and no signal is applied. A cure is usually effected by the use of plate resistors (about 10 ohms), and loading each half of the input transformer secondary with about 50,000 ohms.

It is well to use a battery bias. If a bias rectifier is used, care should be taken to see that the bleeder resistance is not too high, and that it is shunted by at least an 8 mf. condenser.

Table VI shown below gives the maximum signal operation of a pair of Type HK-354 GAMMATRONS in Class B push-pull. Table VII contains data for a pair of the same tubes with less driving power available. No allowance is made in either case for transformer losses. The driving equipment indicated is in the nature of a suggestion. Tubes of equivalent power output may be used as desired. Further information on the operation of Class B amplifiers may be found in current texts and literature.

CLASS "B" AUDIO AMPLIFIER PERFORMANCE

(TWO TUBES)

(Total arithmetic sum of 3rd, 5th, 7th, and 9th harmonics not to exceed 2.5%)

TABLE VI (WITH MAXIMUM SIGNAL)

Plate Potential Supply Volts	No-signal ₁ Plate Milli- amperes	Grid Bias in Volts	Plate-to-Plate Load Resistance Ohms	Grid-to-Grid Peak Signal Volts	Peak ₂ Driving Power Watts	Plate Current Milli- amperes	Power Output in Watts	Plate ₃ Loss in Watts	Plate Efficiency in Watts	Driver Trans- former Ratio
[See (A) below]										
1000	40	- 60	10,000	340	14	232	162	70	70	1.5 :1
1500	60	- 95	10,000	440	20	324	315	170	65	1.25:1
2000	100	-125	10,000	500	20	388	488	288	63	1.0 :1
2500	80	-165	15,000	560	20	350	577	298	66	0.9 :1
3000	65	-205	22,000	630	20	313	665	273	71	0.8 :1

TABLE VII (WITH MEDIUM SIGNAL)

[See (B) below]										
1000	40	- 60	10,000	260	5	178	96	82	54	1.75:1
1500	60	- 95	10,000	320	5	236	166	188	47	1.50:1
2000	100	-125	10,000	380	5	294	276	312	47	1.0 :1
2500	80	-165	15,000	430	5	267	333	333	50	0.9 :1
3000	65	-205	22,000	510	5	252	431	325	57	

(A) Suggested driver, four Type 2A5 or 42 tubes in push-pull parallel triode connection (screen tied to plate) with 350 plate volts and fixed bias.

(B) Suggested driver, two Type 2A5 or 42 tubes in push pull triode connection (screen tied to plate) with 350 plate volts and fixed bias.

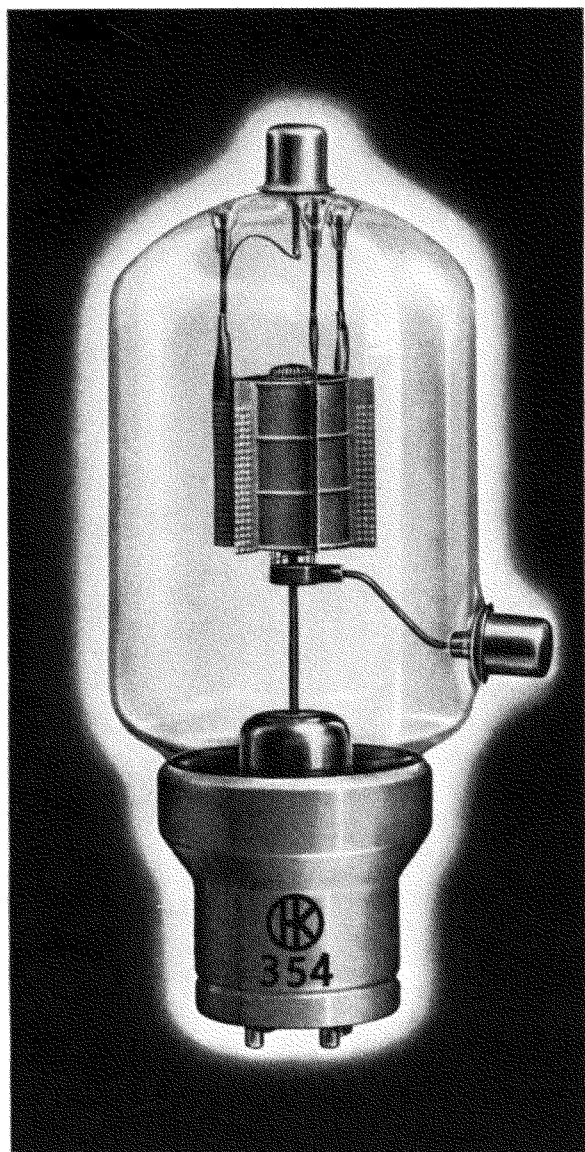
₁Lower no-signal plate currents will cause somewhat higher distortion.

₂Instantaneous peak power in watts drawn by grid at crest of wave. Effective power is one-half this value.

₃Plate loss may be slightly greater at lower signal levels.

GAMMATRONS HAVE TANTALUM PLATES and GRIDS!

GAMMATRON TYPE 354



GENERAL PURPOSE TRIODE

150 watt radiation cooled triode, available in two amplification factors: The C a low mu of 14 and the E a high mu of 35. Exceptional HF performance and ability to withstand high voltages.

PHYSICAL DATA

Plate	Cylindrical Tantalum
Grid	Braced Vertical Bar Tantalum
Filament	Thoriated Tungsten
Base	Standard Fifty Watt
Net Weight	8½ Ounces
Shipping Weight	3 Pounds
Maximum Height	9 ³ / ₁₆ Inches
Maximum Diameter	3 ⁷ / ₁₆ Inches

ELECTRICAL DATA

	C	E
Filament Voltage	5.0	5.0 Volts
Filament Current	10	10 Amps.
Normal Plate Dissipation	150	150 Watts
Maximum Plate Input	750	750 Watts
Maximum D.C. Plate Current	300	300 M. A.
Maximum D.C. Plate Voltage	4000	4000 Volts
Maximum D.C. Grid Current	60	85 M. A.
Average Amplification Constant	14	35
Grid-Plate Capacitance	3.3	3.3 Mmfd.
Grid-Filament Capacitance	4.4	4.6 Mmfd.
Plate-Filament Capacitance	0.7	0.5 Mmfd.

The 354 GAMMATRON is a general purpose triode. It has a tantalum plate and grid and embodies the fundamental design features characteristic of GAMMATRON transmitting tubes. Scientific engineering, combined with the highest manufacturing skill, results in a definite superiority over tubes of conventional design.

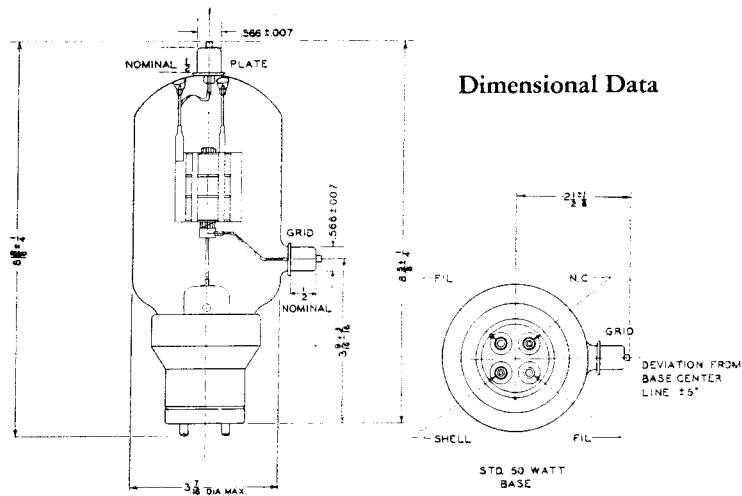
The plate and grid are mounted on short, direct, low inductance leads. Internal insulators are completely eliminated while perfect alignment is maintained and extremely high interelectrode insulation is permitted. Thus, with the use of tantalum and the elimination of unnecessary internal struc-

ture, it is possible to completely out-gas GAMMATRON tubes without the use of the usual "getter." This excellent vacuum is retained throughout the full life and it is not possible to cause this tube to go soft due to overload. The filament may then be operated in a manner consistent with high thermionic efficiency and long life.

The GAMMATRON method of design results in a tube that is easy to neutralize because of its low interelectrode capacity. It is easy to drive because of its special vertical grid bar design, and it has extremely long life because of its ability to maintain a permanent vacuum of a high degree.

TYPE 354 GAMMATRON

The information on this and the following page does not represent exact conditions of operation to be imposed for any particular situation. Because tubes are used under many widely different conditions Heintz and Kaufman will gladly furnish information for applications which differ appreciably from the illustrative examples given.



RADIO FREQUENCY POWER AMPLIFIER CLASS "C" UNMODULATED

C					E				
Maximum Rating Per Tube		Typical Operation, 1 Tube			Maximum Rating Per Tube		Typical Operation, 1 Tube		
Power Output.....		600	600	450		600	600	450	Watts
Driving Power.....		15	29	31		16	23	28	Watts
DC Plate Voltage.....	4000	4000	3000	2000	4000	4000	3000	2000	Volts
DC Plate Current.....	300	187	250	300	300	185	250	300	ma
DC Grid Current.....	60	30	50	60	75	45	55	65	ma
DC Grid Voltage.....	−1000	−400	−400	−300	−1000	−220	−220	−200	Volts
Peak RF Grid Voltage.....		580	650	570		420	470	475	Volts
Plate Dissipation.....	150	135	150	150	150	150	150	150	Watts
Plate Input.....	750	750	750	600	750	750	750	600	Watts

RADIO FREQUENCY POWER AMPLIFIER* CLASS "C" PLATE MODULATED

C						E				
Maximum Rating Per Tube		Typical Operation, 1 Tube				Maximum Rating Per Tube		Typical Operation, 1 Tube		
Power Output.....		505	450	380	275		505	450	375	Watts
Driving Power.....		22	25	27	25		25	27	32	Watts
DC Plate Voltage.....	3000	3000	2500	2000	1500	3000	3000	2500	2000	Volts
DC Plate Current.....	250	210	230	250	250	250	210	230	250	ma
DC Grid Current.....	60	50	55	60	60	75	50	55	60	ma
DC Grid Voltage.....	−1000	−300	−300	−275	−225	−1000	−325	−325	−350	Volts
Peak RF Grid Voltage.....		500	515	505	455		560	575	625	Volts
Plate Dissipation.....	127	125	125	120	100	127	125	125	125	Watts
Plate Input.....	635	630	575	500	375	635	630	575	500	Watts

*Carrier Conditions for 100% modulation peaks and 60% average value.

Gammatron Tubes

AUDIO FREQUENCY POWER AMPLIFIER*

CLASS "B"

	Maximum Rating 2 Tubes	C			E		
		Typical Operation, 2 Tubes			Typical Operation, 2 Tubes		
Power Output.....		810	700	660	810	700	660 Watts
Driving Power**.....		55	50	60	45	50	60 Watts
DC Plate Voltage.....	4000	3000	2500	2000	3000	2500	2000 Volts
DC Plate Current, Zero Signal.....		50	60	70	50	60	70 ma
DC Plate Current, Max. Signal.....	600	370	400	480	370	400	480 ma
DC Grid Voltage.....		-220	-175	-140	-70	-50	-35 Volts
Peak AF Grid to Grid Voltage.....		740	630	640	470	460	470 Volts
Plate Input, Max. Signal.....	1125	1110	1000	960	1110	1000	960 Watts
Load Resistance Plate to Plate.....		19200	14400	9300	19200	14400	9300 Ohms

*All data for two tubes.

**Instantaneous power at crest of cycle; effective power is 1/2 of this value.

RADIO FREQUENCY POWER AMPLIFIER*

CLASS "B"

	Maximum Rating Per Tube	C			E		
		Typical Operation, 1 Tube			Typical Operation, 1 Tube		
Power Output.....		90	75	60	90	75	60 Watts
Driving Power**.....		6	10	28	5	11	30 Watts
DC Plate Voltage.....	3000	3000	2000	1000	3000	2000	1000 Volts
DC Plate Current.....	250	80	112	210	80	112	210 ma
DC Grid Current.....		0	0	10	1	5	18 ma
DC Grid Voltage.....		-250	-150	-75	-75	-50	-25 Volts
Peak RF Grid Voltage.....		195	160	180	112	120	157 Volts
Plate Dissipation.....	150	150	150	150	150	150	150 Watts
Plate Input.....	240	240	225	210	240	225	210 Watts

*Carrier Conditions for 100% modulation.

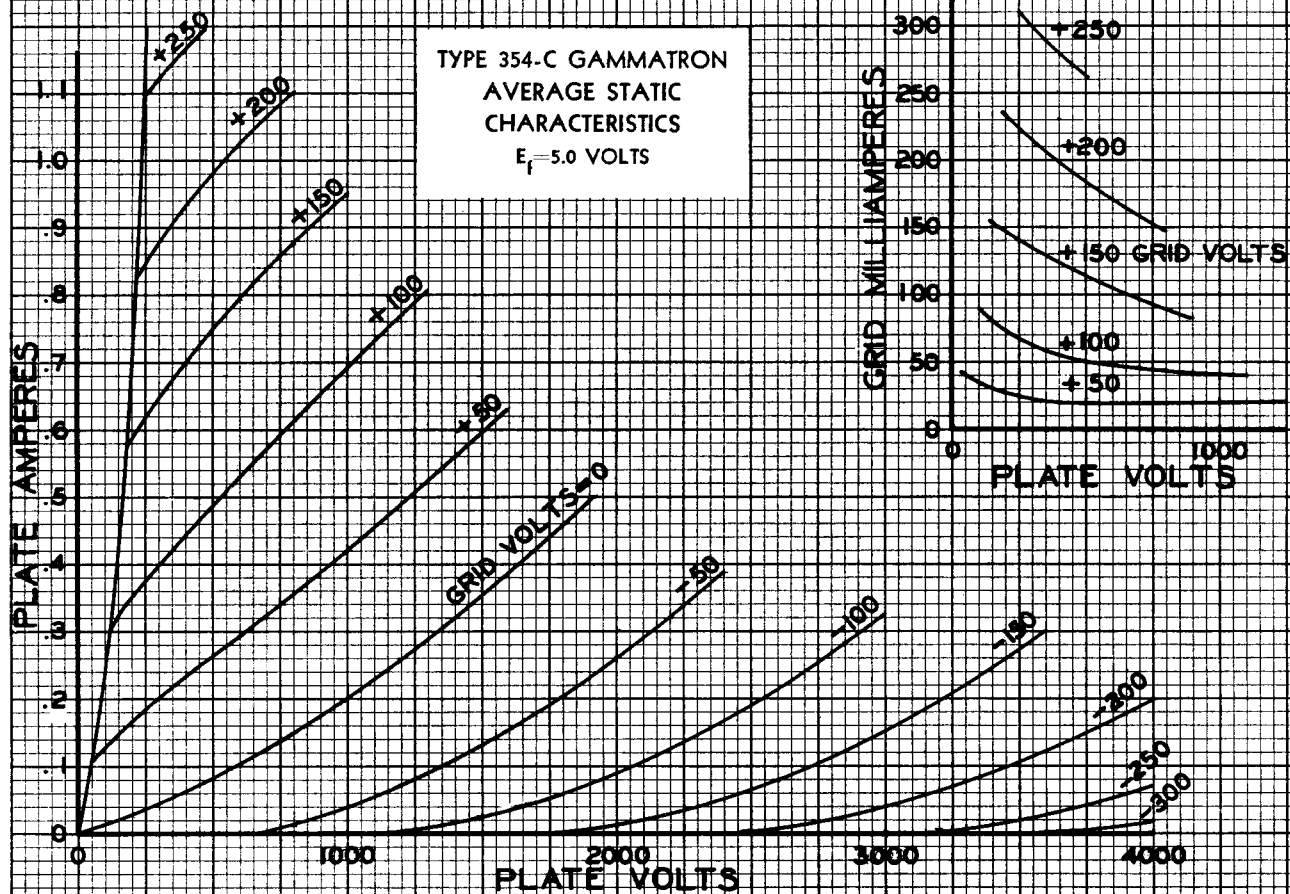
**RF Power at crest of audio cycle.

HIGH FREQUENCY PERFORMANCE C AND E

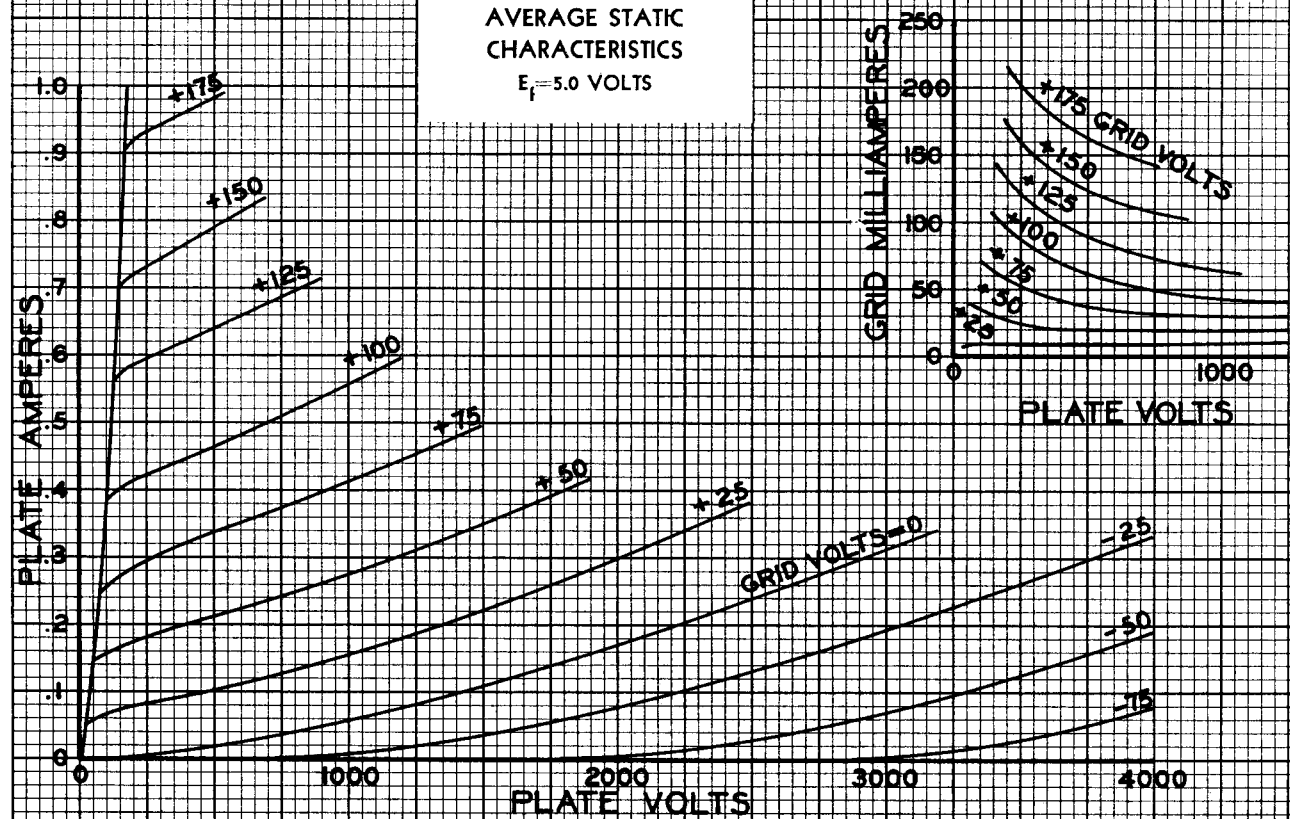
Frequency.....		15	25	35	mc
Class C Unmodulated					
Max. Input.....	600	555	450	Watts	
Max. Plate Volts.....	3200	3000	2400	Volts	
Typical Plate Efficiency.....	75	73	67	Pct.	
Class C Modulated					
Max. Input.....	510	470	380	Watts	
Max. Plate Volts.....	2500	2400	2000	Volts	
Class B Linear					
Max. Input.....	225	220	215	Watts	
Max. Plate Volts.....	3200	3000	2400	Volts	

Gammatron Tubes

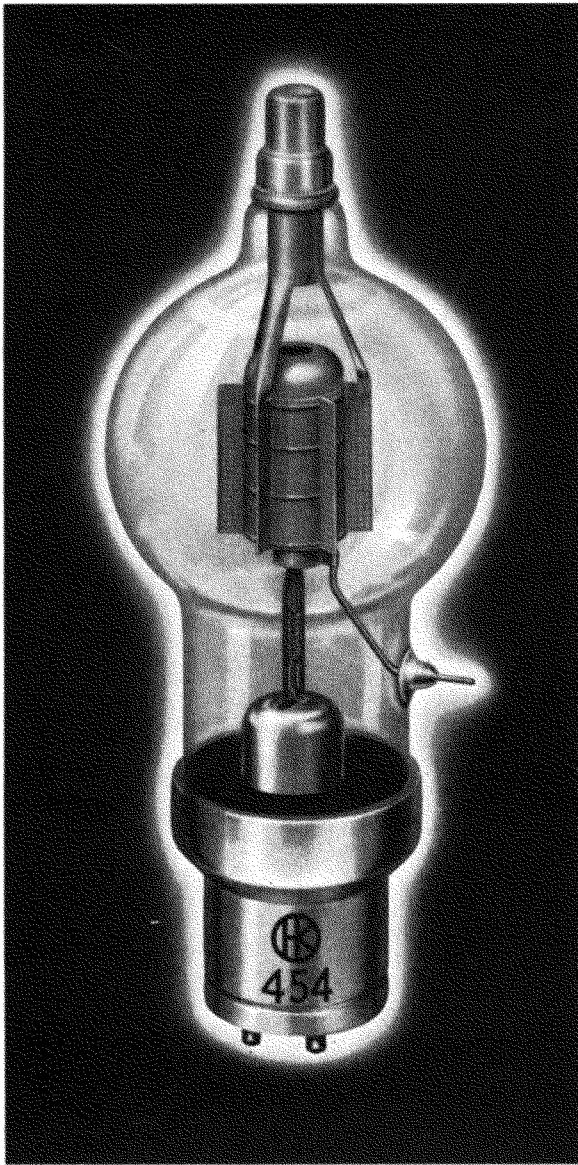
TYPE 354-C GAMMATRON
AVERAGE STATIC
CHARACTERISTICS
 $E_f = 5.0$ VOLTS



TYPE 354-E GAMMATRON
AVERAGE STATIC
CHARACTERISTICS
 $E_f = 5.0$ VOLTS



GAMMATRON TYPE 454



GENERAL PURPOSE TRIODE

250 watt radiation cooled triode, available in two amplification factors: **L**ow mu 13.5 and **H**igh mu 27. Exceptional VHF performance and ability to stand high voltages.

PHYSICAL DATA

Plate	Cylindrical Tantalum
Grid	Braced Vertical Bar Tantalum
Filament	Thoriated Tungsten
Blank	Nonex Glass
Base	Standard Fifty Watt
Net Weight	9 Ounces
Shipping Weight	21½ Pounds
Shipping Volume	0.6 Cu. Feet
Maximum Height	10½ Inches
Diameter	3½ Inches

ELECTRICAL DATA

	L	H
Filament Voltage	5.0	5.0 Volts
Filament Current	10	10 Amps.
Normal Plate Dissipation	250	250 Watts
Maximum Average Plate Current	375	375 M. A.
Maximum Plate Voltage	5000	5000 Volts
Maximum Average Grid Current	60	85 M. A.
Average Amplification Constant	13.5	27
Grid-Plate Capacitance	3.2	3.5 mmf.
Grid-Filament Capacitance	3.9	4.1 mmf.
Plate-Filament Capacitance	0.7	0.6 mmf.

Unique constructional features make this tube capable of high voltages and of unusual very high frequency performance. It has exceptional ruggedness, electrical stamina, and extra long life.

Copper thimble connectors are used for the plate terminal. They are high current capacity connectors possessing low resistance. Because of improved radiation, they run at least 50 degrees Centigrade cooler at the copper to glass seal than do ordinary tungsten seals. Their design relieves glass strains, and hence the seal positively will not fail. Heavy, rugged leads provide perfect support and alignment to the elements without the use of insulators. Their low inductance com-

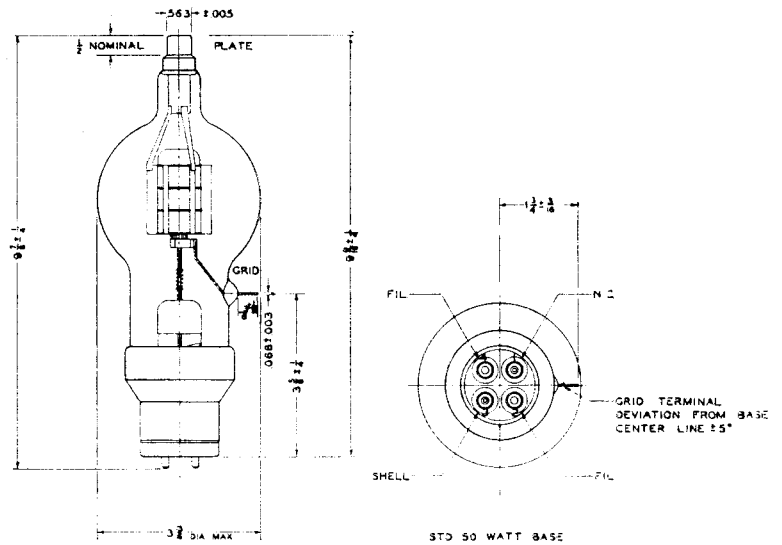
bined with low interelectrode capacity provides easy neutralization and reduces circuit losses at high frequencies.

The VHF efficiency is high because of the use of an enclosed plate which confines all electrons to give useful output. Ordinary open plate tubes operate at lower efficiency because of escaped electrons. Electron bombardment is eliminated, lifting voltage limitations. Operation as a neutralized power amplifier up to 150 mc is practical with 70% efficiency.

New tantalum cleaning and pumping techniques give the 454 extra long life, and make it more gas free—more failure proof. A result of 17 years of GAMMATRON progress.

TYPE HK 454

The information on this and the following page does not represent exact conditions of operation to be imposed for any particular situation. Because tubes are used under many widely different conditions Heintz and Kaufman will gladly furnish information for applications which differ appreciably from the illustrative examples given.



RADIO FREQUENCY POWER AMPLIFIER CLASS "C" UNMODULATED

L

	Maximum Rating Per Tube	Typical Operation, 1 Tube		
Power Output.....		900	750	525
Driving Power.....		26	35	40
DC Plate Voltage.....	5000	4000	3000	2000
DC Plate Current.....	375	280	325	375
DC Grid Current.....	60	37	50	60
DC Grid Voltage.....	-1000	-500	-450	-375
Peak RF Grid Voltage.....		790	780	735
Plate Dissipation.....	250	225	225	225
Plate Input.....	1125	1125	975	750

H

	Maximum Rating Per Tube	Typical Operation, 1 Tube		
Power Output.....		900	775	540 Watts
Driving Power.....		27	35	40 Watts
DC Plate Voltage.....	5000	4000	3000	2000 Volts
DC Plate Current.....	375	280	335	375 ma
DC Grid Current.....	85	55	70	80 ma
DC Grid Voltage.....	-1000	-300	-275	-250 Volts
Peak RF Grid Voltage.....		555	565	560 Volts
Plate Dissipation.....	250	225	225	210 Watts
Plate Input.....	1125	1125	1000	750 Watts

RADIO FREQUENCY POWER AMPLIFIER* CLASS "C" PLATE MODULATED

L

	Maximum Rating Per Tube	Typical Operation, 1 Tube		
Power Output.....		760	560	440
Driving Power.....		30	32	33
DC Plate Voltage.....	4000	3500	2500	2000
DC Plate Current.....	300	270	300	300
DC Grid Current.....	60	45	50	55
DC Grid Voltage.....	-1000	-450	-400	-350
Peak RF Grid Voltage.....		730	710	660
Plate Dissipation.....	210	190	190	160
Plate Input.....	950	950	750	600

H

	Maximum Rating Per Tube	Typical Operation, 1 Tube		
Power Output.....		760	575	450 Watts
Driving Power.....		28	33	31 Watts
DC Plate Voltage.....	4000	3500	2500	2000 Volts
DC Plate Current.....	300	270	300	300 ma
DC Grid Current.....	85	60	70	70 ma
DC Grid Voltage.....	-1000	-275	-250	-225 Volts
Peak RF Grid Voltage.....		525	515	490 Volts
Plate Dissipation.....	210	190	175	150 Watts
Plate Input.....	950	950	750	600 Watts

*Carrier Conditions for 100% modulation peaks and 60% average value.

Gammatron Tubes

AUDIO FREQUENCY POWER AMPLIFIER*

CLASS "B"

		L			H		
	Maximum Rating 2 Tubes	Typical Operation, 2 Tubes			Typical Operation, 2 Tubes		
Power Output.....		1020	960	800	1020	960	900 Watts
Driving Power**.....		70	85	80	45	75	90 Watts
DC Plate Voltage.....	4000	3500	2500	2000	3500	2500	2000 Volts
DC Plate Current, Zero Signal..		60	90	100	60	90	100 ma
DC Plate Current, Max. Signal..	750	410	550	640	410	550	660 ma
DC Grid Voltage.....		-260	-165	-125	-110	-75	-50 Volts
Peak RF Grid to Grid Voltage.....		930	850	800	560	590	600 Volts
Plate Input, Max. Signal.....	1500	1435	1375	1280	1435	1375	1320 Watts
Load Resistance Plate to Plate.....		20,000	10,000	6400	20,000	10,000	6400 Ohms

*All data for two tubes.

**Instantaneous power at crest of cycle; effective power is 1/2 of this value.

RADIO FREQUENCY POWER AMPLIFIER*

CLASS "B"

		L			H		
	Maximum Rating Per Tube	Typical Operation, 1 Tube			Typical Operation, 1 Tube		
Power Output.....		125	115	100	130	115	105 Watts
Driving Power**.....		12	20	26	12	20	28 Watts
DC Plate Voltage.....	4000	3000	2000	1500	3000	2000	1500 Volts
DC Plate Current.....	300	115	170	215	120	170	220 ma
DC Grid Current.....		0	1	3	1	4	6 ma
DC Grid Voltage.....		-250	-170	-125	-120	-80	-60 Volts
Peak RF Grid Voltage.....		235	225	225	155	165	175 Volts
Plate Dissipation.....	250	225	225	225	225	225	225 Watts
Plate Input.....	360	350	340	320	360	340	330 Watts

*Carrier Conditions for 100% modulation.

**RF Power at crest of audio cycle.

VERY HIGH FREQUENCY PERFORMANCE L AND H

Frequency	25	50	100	150 mc
Class "C" Unmodulated				
Typical Plate Efficiency, Percent.....	80	78	74	69
Max. Plate Input, Watts.....	1125	1000	860	720
Max. Plate Voltage, Volts.....	5000	4400	3800	3200
Class "C" Modulated				
Typical Plate Efficiency, Percent.....	80	78	74	69
Max. Plate Input, Watts.....	950	850	730	650
Max. Plate Voltage, Volts.....	4000	3600	3100	2750
Class "B" Linear				
Typical Plate Efficiency, Percent.....	35	34	32	30
Max. Plate Input, Watts.....	360	350	340	330
Max. Plate Voltage, Volts.....	4000	3900	3800	3700

Gammatron Tubes

