



TECHNICAL DATA

8166
4-1000A
RADIAL-BEAM
POWER TETRODE

The EIMAC 8166/4-1000A is a radial-beam tetrode with a maximum plate dissipation rating of 1000 watts. Intended for use as an amplifier, oscillator, or modulator, the 8166/4-1000A is capable of efficient operation well into the VHF range.

In FM broadcast service on 110 Megahertz, two 8166/4-1000A tetrodes will deliver a useful output power of over 5000 watts.

Operating under class AB₂ modulator conditions with less than 10 watts of peak driving power, two of these tubes will deliver 3900 watts of output power.

In class AB₁, a pair of 8166/4-1000A tetrodes will deliver 3800 watts of output power.

Cooling of the tube is accomplished by radiation from the plate and by circulation of forced-air through the base and around the envelope. Cooling can be simplified through the use of the EIMAC SK-500 Air-System Socket.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten		Min.	Nom.	Max.	
Voltage - - - - -			7.5		volts
Current - - - - -		20.0		22.7	amperes
Amplification Factor (Grid to Screen)	- - - - -	6.1		7.7	
Direct Interelectrode Capacitances:†					
Grid-Plate - - - - -				0.35	μμf
Input - - - - -		23.8		32.4	μμf
Output - - - - -		6.8		9.4	μμf
Transconductance (I _b =300 ma)	- - - - -		10,000		μmhos
Highest Frequency for Maximum Ratings	- - - - -			110	MHz

MECHANICAL

Base - - - - -					5-pin metal shell
Basing - - - - -					See drawing
Recommended Socket - - - - -					EIMAC SK-500 Air-System Socket
Recommended Chimney - - - - -					SK-506
Operating Position - - - - -					Vertical, base up or down
Cooling - - - - -					Radiation and forced air
Recommended Heat-Dissipating Connector:					
Plate - - - - -					EIMAC HR-8
Maximum Over-all Dimensions:					
Length - - - - -					9.63 inches
Diameter - - - - -					5.25 inches
Net Weight (tube only)	- - - - -				1.5 pounds
Shipping Weight - - - - -					12 pounds

†In Shielded Fixture

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RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telegraphy or FM Telephony

MAXIMUM RATINGS (Key-down conditions, per tube to 110 MHz)

[illegible]

TYPICAL OPERATION (Frequencies below 110 MHz,
one tube)

DC Plate Voltage	-	-	-	-	-	3000	4000	5000	6000	volts
DC Screen Voltage	-	-	-	-	-	500	500	500	500	volts
DC Grid Voltage	-	-	-	-	-	-150	-150	-200	-200	volts
DC Plate Current	-	-	-	-	-	700	700	700	700	ma
DC Screen Current	-	-	-	-	-	146	137	147	140	ma
DC Grid Current	-	-	-	-	-	38	39	45	42	ma
Screen Dissipation	-	-	-	-	-	73	69	73	70	watts
Grid Dissipation	-	-	-	-	-	5	6	7	6	watts
Peak RF Grid Input Voltage (approx.)	-	-	-	-	-	290	290	355	350	volts
Driving Power (approx.)*	-	-	-	-	-	11	12	16	15	watts
Plate Input Power	-	-	-	-	-	2100	2800	3500	4200	watts
Plate Dissipation	-	-	-	-	-	670	700	690	800	watts
Plate Output Power	-	-	-	-	-	1430	2100	2810	3400	watts

*Apparent driving power requirements increase above 30 MHz. At 110 MHz the driver should be capable of supplying 200 watts per tube to take care of feed-through, circuit losses, and radiation.

TYPICAL OPERATION (110 MHz, two tubes, push-pull)

DC Plate Voltage	-	-	-	-	4000	5000	6000	volts
DC Screen Voltage	-	-	-	-	450	500	500	volts
DC Grid Voltage	-	-	-	-	-150	-160	-180	volts
DC Plate Current	-	-	-	-	1.15	1.25	1.25	amps
DC Screen Current	-	-	-	-	280	240	250	ma
DC Grid Current	-	-	-	-	80	80	100	ma
Screen Dissipation (per tube)	-	-	-	-	63	60	63	watts
Driving Power (approx.)	-	-	-	-	350	400	400	watts
Plate Input Power	-	-	-	-	4600	6250	7500	watts
Plate Dissipation (per tube)	-	-	-	-	650	850	900	watts
Useful Output Power	-	-	-	-	3000	4200	5200	watts

These 110 MHz typical performance figures were obtained by direct measurement in operating equipment. The output power is useful power measured in a load circuit. The driving power is that taken by the tube and a practical resonant circuit. In many cases with further refinement and improved techniques, better performance might be obtained.

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Class-C Telephony (Carrier Conditions)

MAXIMUM RATINGS (Per tube to 110 MHz)

DC PLATE VOLTAGE	-	-	-	-	-	5000	VOLTS†
DC SCREEN VOLTAGE	-	-	-	-	-	1000	VOLTS
DC GRID VOLTAGE	-	-	-	-	-	—500	VOLTS
DC PLATE CURRENT	-	-	-	-	-	600	MA
PLATE DISSIPATION	-	-	-	-	-	670	WATTS
SCREEN DISSIPATION	-	-	-	-	-	25	WATTS
GRID DISSIPATION	-	-	-	-	-	75	WATTS

†5500 Max. volts below 30 MHz.

TYPICAL OPERATION (Frequencies below 110MHz, one tube)

DC Plate Voltage	-	-	-	3000	4000	5000	5500	volts
DC Screen Voltage	-	-	-	500	500	500	500	volts
DC Grid Voltage	-	-	-	-200	-200	-200	-200	volts
DC Plate Current	-	-	-	600	600	600	600	ma
DC Screen Current	-	-	-	145	132	130	105	ma
DC Grid Current	-	-	-	36	33	33	28	ma
Screen Dissipation	-	-	-	72	66	63	52	watts
Grid Dissipation	-	-	-	5	4	4	3	watts
Peak AF Screen Voltage (100% modulation)	-	-	-	250	250	250	250	volts
Peak RF Grid Input Voltage	-	-	-	340	335	335	325	volts
Driving Power**	-	-	-	12	11	11	9	watts
Plate Input Power	-	-	-	1800	2400	3000	3300	watts
Plate Dissipation	-	-	-	410	490	560	670	watts
Plate Output Power	-	-	-	1390	1910	2440	2630	watts

*5500 volt operation may be used below 30 MHz only.

**Apparent driving power requirements increase above 30 MHz. At 110 MHz the driver should be capable of supplying 200 watts per tube to take care of feed-through, circuit losses, and radiation.

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class-AB

MAXIMUM RATINGS (Per tube)

[illegible]

TYPICAL OPERATION Class-AB₁

(Sinusoidal wave, two tubes unless otherwise specified)

DC Plate Voltage - - - - -	4000	5000	6000	volts
DC Screen Voltage - - - - -	1000	1000	1000	volts
DC Grid Voltage (approx.)* - - - - -	-115	-125	-135	volts
Zero-Signal DC Plate Current - - - - -	300	240	200	ma
Max-Signal DC Plate Current - - - - -	1.05	1.00	0.95	amps
Zero-Signal DC Screen Current - - - - -	0	0	0	ma
Max-Signal DC Screen Current - - - - -	60	60	64	ma
Effective Load, Plate-to-Plate - - - - -	7000	10,000	14,000	ohms
Peak AF Grid Input Voltage (per tube) - - - - -	115	125	135	volts
Driving Power - - - - -	0	0	0	watts
Max-Signal Plate Dissipation (per tube) - - - - -	930	950	930	watts
Max-Signal Plate Output Power - - - - -	2340	3100	3840	watts

*Adjust to give stated zero-signal plate current. The DC resistance in series with the control grid of each tube should not exceed 250,000 ohms.

TYPICAL OPERATION Class-AB₂

(Sinusoidal wave, two tubes unless otherwise specified)

DC Plate Voltage	-	-	-	4000	5000	6000	volts
DC Screen Voltage	-	-	-	500	500	500	volts
DC Grid Voltage (approx.)*	-	-	-	60	70	75	volts
Zero-Signal DC Plate Current	-	-	-	300	200	150	ma
Max-Signal DC Plate Current	-	-	-	1.20	1.10	.95	amps
Zero-Signal DC Screen Current	-	-	-	0	0	0	ma
Max-Signal DC Screen Current	-	-	-	.95	.90	.65	ma
Effective Load, Plate-to-Plate	-	-	-	7000	11,000	15,000	ohms
Peak AF Grid Input Voltage (per tube)	-	-	-	140	145	130	volts
Max-Signal Peak Driving Power	-	-	-	11.0	11.0	9.4	watts
Max-Signal Nominal Driving Power (approx.)	-	-	-	5.5	5.5	4.7	watts
Max-Signal Plate Dissipation (per tube)	-	-	-	900	850	900	watts
Max-Signal Plate Output Power	-	-	-	3000	3800	3900	watts

*Adjust to give stated zero-signal plate current.

Note: Typical operation data are based on conditions of adjusting the rf grid drive to a specified plate current, maintaining fixed conditions of grid bias and screen voltage. It will be found that if this procedure is followed there will be little variation in output power between tubes even though there may be some variation in grid and screen currents. Where grid bias is obtained principally by means of a grid resistor, it is necessary to make the resistor adjustable to control plate current.

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION," POSSIBLY EXCEEDING THE MAXIMUM RATINGS GIVEN FOR CW SERVICE, WRITE EIMAC DIVISION OF VARIAN ASSOCIATES, FOR INFORMATION AND RECOMMENDATIONS

APPLICATION

MECHANICAL

Mounting — The 4-1000A must be operated vertically. The base may be down or up. The recommended socket for this tube is the SK-500 Air-System Socket.

Cooling — Adequate forced-air cooling must be provided to maintain the base seal temperatures below 150°C and the plate seal temperature below 200°C. Cooling is simplified by the use of the EIMAC SK-500 Air-System Socket, and its SK-506 Air Chimney, which control the flow of air around the tube.

When the EIMAC SK-500 Air-System Socket is used, the following flow rates apply to sea level operation, with an ambient temperature of 25°C for the operating conditions described:

At 110 megahertz, with maximum rated plate dissipation, an air-flow rate of 35 cfm is required. The corresponding pressure drop as measured in the socket is 1.9 inches of water column.

At frequencies below 30 megahertz, an air-flow rate of 20 cfm provides adequate cooling. The corresponding pressure drop as measured in the socket is 0.6 inch of water column.

In the event that an Air-System Socket and Air Chimney are not used, air must be circulated through the base of the tube and over the envelope surface and the plate seal in sufficient quantities to maintain the temperatures below the maximum ratings. Seal-temperature ratings may require that cooling air be supplied to the tube if the filament is maintained at operating temperature during standby periods.

In any questionable situation, the only criterion for correct cooling practice is temperature. A convenient medium for measuring tube temperatures is a temperature-sensitive paint.

ELECTRICAL

Filament Voltage — For maximum tube life the filament voltage, as measured directly at the filament pins, should be the rated voltage of 7.5 volts. Variations in filament voltage must be kept within the range of 7.13 to 7.87 volts.

Bias Voltage — The dc bias voltage for the 4-1000A should not exceed 500 volts. With grid-leak bias, suitable means must be provided to prevent excessive plate or screen dissipation in

the event of loss of excitation. The grid-resistor should be made adjustable to facilitate maintaining the bias voltage and plate current at the desired values from tube to tube. In the case of operation above 50 megahertz, it is advisable to keep the bias voltage as low as possible.

Screen Voltage — The dc screen voltage for the 4-1000A should not exceed 1000 volts. The screen voltages shown under "Typical Operation" are representative voltages for the type of operation involved.

Plate Voltage — The plate-supply voltage for the 4-1000A should not exceed 6000 volts in CW and audio applications. In plate-modulated telephony service above 30 megahertz, the dc plate-supply voltage should not exceed 5000 volts; however, below 30 megahertz, 5500-volts may be used.

Grid Dissipation — Grid dissipation for the 4-1000A should not be allowed to exceed 25 watts. Grid dissipation may be calculated from the following expression:

$$P_g = e_{\text{emp}} I_g$$

where: P_g = Grid dissipation,

e_{emp} = Peak positive grid to cathode voltage

I_g = DC grid current.

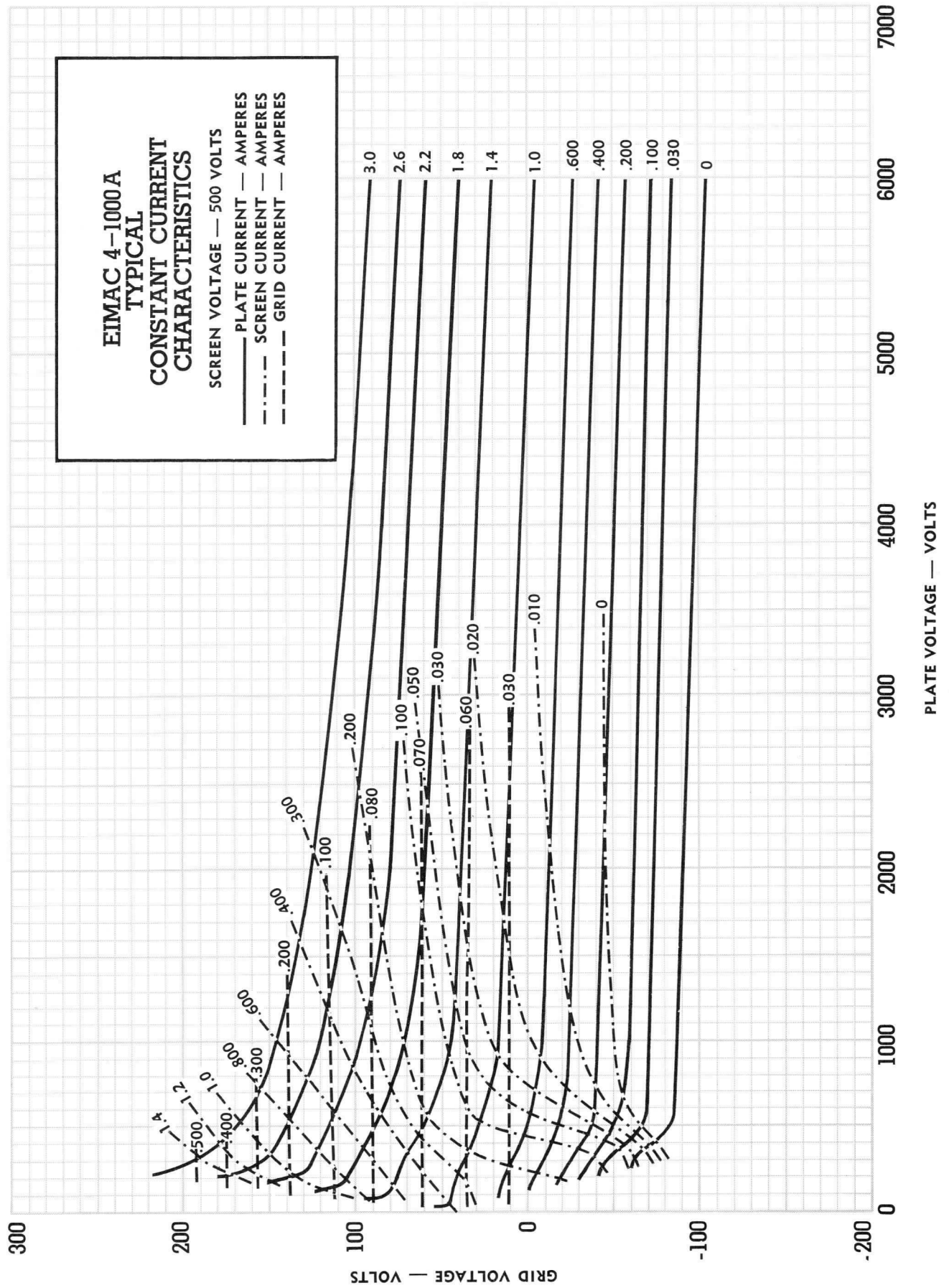
e_{emp} may be measured by means of a suitable peak voltmeter connected between filament and grid.

Screen Dissipation — The power dissipated by the screen of the 4-1000A must not exceed 75 watts. Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit screen dissipation to 75 watts in event of circuit failure.

Plate Dissipation — Under normal operating conditions, the plate dissipation of the 4-1000A should not be allowed to exceed 1000 watts.

In plate-modulated amplifier applications, the maximum allowable carrier-condition plate dissipation is 670 watts. The plate dissipation will rise to 1000 watts under 100 per-cent sinusoidal modulation.

Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.



Neutralization — If reasonable precautions are taken to prevent coupling between input and output circuits, the 4-1000A may be operated up to the 10-megahertz region without neutralization. In the region between 10 megahertz and 30 megahertz, the conventional type of cross-neutralizing may be used with push-pull circuits. In single-ended circuits ordinary neutralization systems may be used which provide 180° out of phase voltage to the grid.

At frequencies above 30 megahertz the feedback is principally due to screen-lead-inductance effects. Feedback is eliminated by using series capacitance in the screen leads between the screen and ground. A variable capacitor of from 25 to 50 $\mu\mu\text{fds}$ will provide sufficient capacitance to neutralize each tube in the region of 100 megahertz. When using this method, the two screen terminals on the socket should be strapped together by the shortest possible lead. The lead from the mid-point of this screen strap

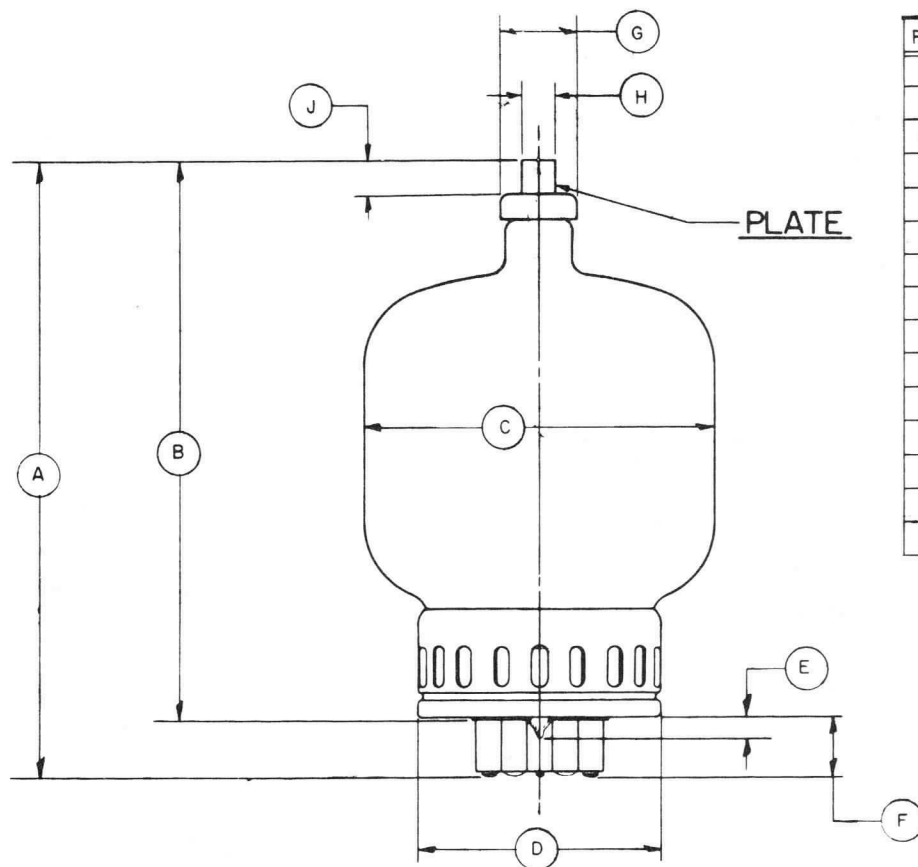
to the variable capacitor and from the variable capacitor to ground should have as little inductance as possible.

In general, plate, grid, filament, and screen-bypass or screen-neutralizing capacitors should be returned to rf ground through the shortest possible leads.

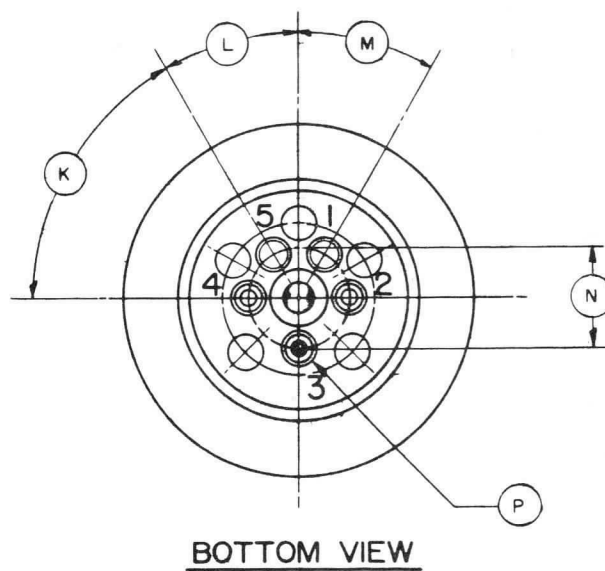
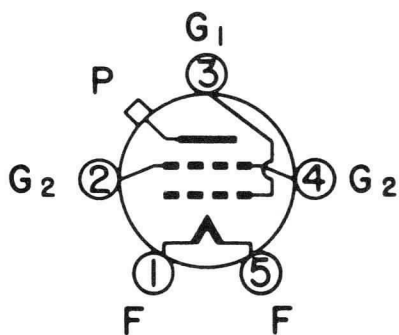
In order to take full advantage of the high power gain obtainable with the 4-1000A, care should be taken to prevent feedback from the output to input circuits. A conventional method of obtaining the necessary shielding between the grid and plate circuits is to use a suitable metal chassis with the grid circuit mounted below the deck and the plate circuit mounted above the deck. Power-supply leads entering the amplifier should be bypassed to the ground and properly shielded to avoid feedback coupling in these leads. The output circuit and antenna feeders should be arranged so as to preclude any possibility of feedback into other circuits.



4-1000A



REF.	MIN.	NOM.	MAX.
A	8.875	9.250	9.625
B	8.000	8.375	8.750
C			5.250
D			3.625
E			.313
F	.825	.875	.925
G	1.110	1.125	1.140
H	.559	.566	.573
J	.484		
K		60°	
L		30°	
M		30°	
N	1.495	1.500	1.505
P	.371	.374	.377



DIMENSIONS
IN INCHES