USE OF TRIODE-CONNECTED TETRODES AS GROUNDED GRID AMPLIFIERS

The tetrode tube may be connected for hi-mu triode operation by placing the grid and screen elements at the same dc and signal potential (figure 1). Low-mu triode operation may be approximated by connecting the screen to the plate (figure 2). This connection is not recommended for grounded-grid operation, as the tube amplification factor is extremely low and screen dissipation is high.

Hi-mu triode connection, however, offers several advantages for SSB operation. No grid bias or screen power supplies are needed and the drive level of the grounded grid stage is compatable with the power output of the modern sideband exciters. Finally, neutralization is not required in a properly designed HF amplifier.

Certain tetrodes do not perform well when connected in the grounded grid circuit of figure 1. These tubes are characterized by high perveance, together with extremely small spacing between the grid bars, and between the grid structure and the cathode. Thus, while performing in excellent fashion in a grid driven circuit, this family of tubes is unsuited for grounded grid operation. Tubes of the 4-65A, 4X150 (which includes the 7609), 4CX250 (which includes the 8930), 4CX300, 4CX350, 4CX1000A, and 4CX1500 families are in this class.

For proper operation of a high-perveance tetrode the screen requires a much large voltage than the control grid. When the electrodes of the tubes are tied together the control grid tends to draw very high current and there is grave risk of destroying it. For example, in grounded grid configuration, the control grid current of the 4X150A is 1.3 amperes at the positive peak of the driving cycle and the peak screen current is 0.5 amperes. At the same instant, the peak plate current is only about 0.8 amperes. In other words, the plate is getting only a third of the current emitted by the cathode instead of nearly all the current! By any standards, such a triode is unsatisfactory. Under these conditions the grid dissipation is about one thousand times as great for the high-mu-connected configuration as it is for the tetrode-connected tube.

The best way to operate tetrodes such as the 4X150A/4CX250B family or the 4CX1000A in a cathode driven linear amplifier is to ground the grid and screen through bypass capacitors and to operate them at their rated dc voltages, as shown in figure 3. The grid dissipation drops to normal when this is done and stage gain is greatly increased. The screen dissipation is nearly the same as in the normal tetrode connection. Good stage gain can be obtained with this circuit because the driver does not have to supply large screen and grid losses. If it is desired to dissipate excess driving power, it should be expended in a resistive load (figure 4).

Tetrodes such as the 4-125A, 4-250A, 4-400A and the 4-1000A are suitable for connection as grounded grid triodes because of their favorable current division characteristic. In the case of the smaller tubes, maximum power capability is limited by maximum grid dissipation.

The following ratings apply to these tubes for triode connected, grounded grid service:

OPERATING CHARACTERISTICS, EIMAC TETRODES, GROUNDED GRID CONFIGURATION

4-125A (VOICE CONDITIONS)

Dc Plate Voltage	2000	2500	3000	Vdc
Zero-signal dc Plate Current *	10	15	20	mAdc
Single-Tone dc Plate Current	105	110	115	mAdc
Single-Tone dc Screen Current	30	30	30	mAdc
Single-Tone dc Grid Current	55	55	55	mAdc
Single-Tone Driving Power	16	16	16	W
Driving Impedance	340	340	340	Ohms
Load Impedance	10,500	13,500	15,700	Ohms
Plate Input Power	210	275	345	W
Plate Output Power	145	190	240	W

4-400A (VOICE CONDITIONS)

(ratings apply to 4-250A, within plate dissipation rating of 4-250A)

Dc Plate Voltage	2000	2500	3000	Vdc
Zero-Signal dc Plate Current *	60	65	70	mAdc
Single-Tone dc Plate Current	265	270	330	mAdc
Single-Tone dc Screen Current	55	55	55	mAdc
Single-Tone dc Grid Current	100	100	100	mAdc
Single-Tone Driving Power	38	39	40	W
Driving Impedance	160	150	140	Ohms
Load Impedance	3950	4500	5000	Ohms
Plate Input Power	530	675	990	W
Plate Output Power	325	435	600	W

4-1000A (VOICE CONDITIONS)

Dc Plate Voltage	3000	4000	5000	Vdc
Zero-Signal dc Plate Current *	60	80	110	mAdc
Single-Tone dc Plate Current	700	680	650	mAdc
Single-Tone dc Screen Current	105	80	55	mAdc
Single-Tone dc Grid Current	170	150	115	mAdc
Single-Tone Driving Power	120	110	90	W
Driving Impedance	104	106	110	Ohms
Load Impedance	2350	3200	4600	Ohms
Plate Input Power	2100	2700	3250	W
Useful Output Power #	1320	1790	2050	W

\# Useful output power is that which is delivered to the load. It is lower than plate output power because of the losses in the plate tank and amplifier output coupling circuits.

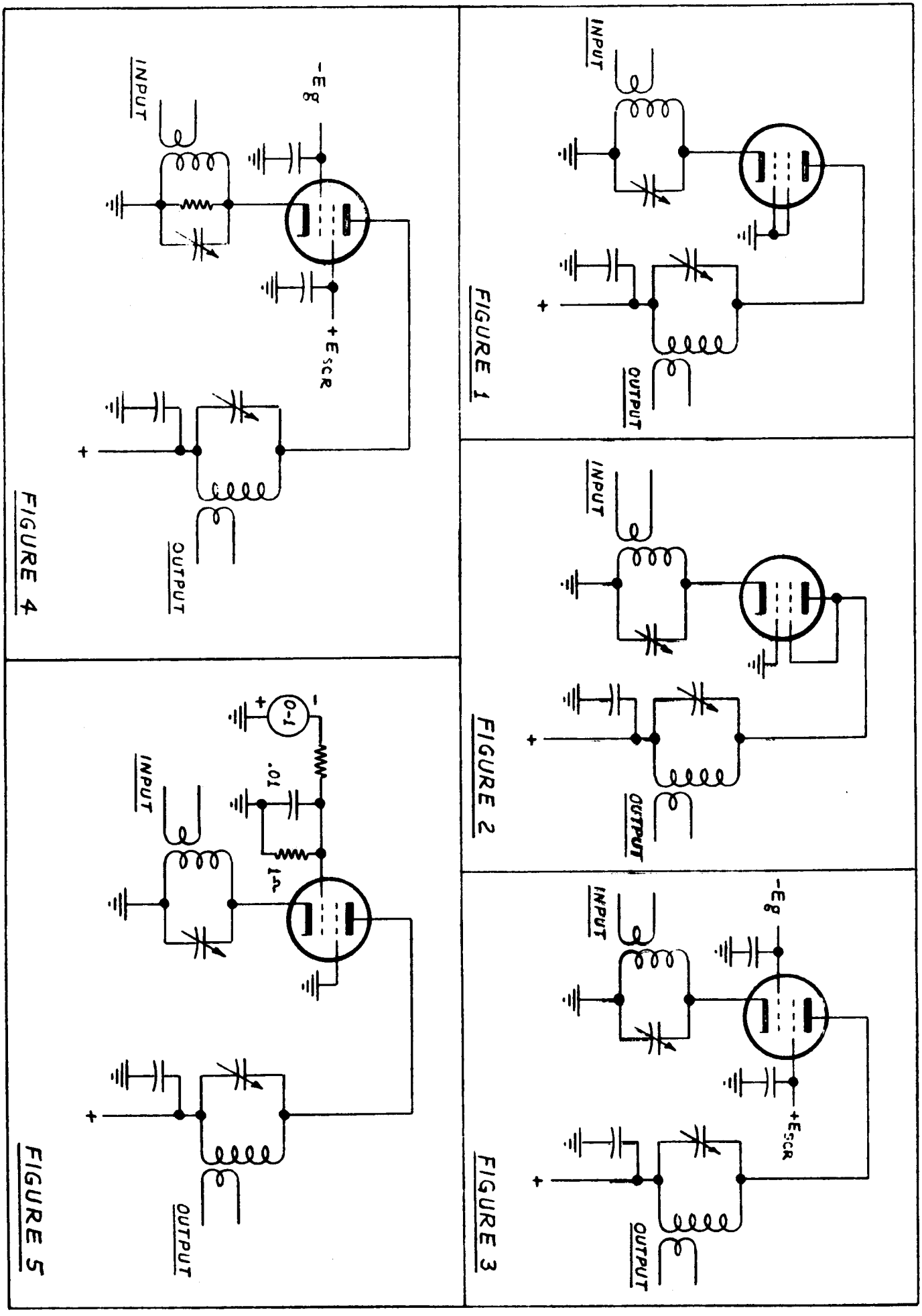
* Zero-signal dc plate current will vary significantly from tube to tube.

In all cases, grid current should be monitored. This may be accomplished by grounding the control grid through a 1-ohm composition resistor, bypassed by one or more .01 MFD disc ceramic capacitors (figure 5). The network serves to hold the control grid very near ground potential. Grid current is monitored by measuring the voltage drop across the 1-ohm resistor. The indicating meter is calibrated in terms of grid current. For example, to have a meter range of 100 milliamperes, the series meter resistor plus the internal meter resistance should equal 100 ohms.

For voice operation, plate or grid current (as read on the meter) will reach a peak value less than the single tone meter reading. Under average conditions, voice current peaks should be approximately one-half the indicated single tone current. For example, a single tone plate current of 300 ma is approximated by voice meter peaks of 150 ma. Driving the voice meter peaks to equal the value of single tone current will result in severe overload distortion.

Use of a high-C tuned cathode circuit in any grounded grid amplifier is mandatory if maximum amplifier efficiency, minimum TVI and lowest intermodulation distortion products are desired. The circuit need only have a Q of 2 or so.

For more information on grounded grid amplifiers and for amplifier design information, refer to the "Radio Handbook," 22nd edition, published by Howard W. Sams Co., 4300 W. 62nd St., Indianapolis, IN 46268.


INPUT
OUTPUT
+
FIGURE 1
INPUT
OUTPUT
+
FIGURE 2
INPUT
-Eg
+ESCR
OUTPUT
+
FIGURE 3
INPUT
-Eg
+ESCR
OUTPUT
+
FIGURE 4
INPUT
0-1
.01
1M
OUTPUT
+
FIGURE 5