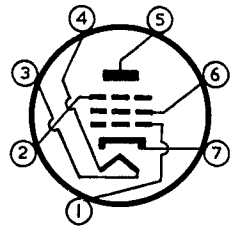
# Grounded-Plate Type 6AU6 Triode Connection For Pre-Amplifier Use*

Difficulty is usually experienced in reducing to satisfactorily low levels the hum and noise from the input stage of a high gain a-f amplifier. If for example noise is required to be 60 db. below full output in an amplifier which is fully driven by a 5 millivolt input signal, then the noise and hum voltage at the grid of the first valve must be 5 microvolts or less.

In valves having the grid brought out to a top cap, the hum voltage induced electromagnetically from stray magnetic fields into the loop of wiring between grid and cathode of the valve may be excessive, and with double-ended valves it is not easy to reduce the area of this loop sufficiently. Further, electrostatic shielding of the grid circuit components and leads, and of the grid cap itself, is




Pin 1 Grid No. 1.
Pin 2 Grid No. 3.
Pin 3 Heater.
Pin 4 Heater.
Pin 5 Plate.
Pin 6 Grid No. 2.
Pin 7 Cathode.

*Fig. 1.—Type 6AU6 base connections.*

*Contributed by the Circuit Design Laboratory, Valve Works, Ashfield.

also necessary, but is difficult to achieve satisfactorily with this type of valve construction.

Single-ended valves minimize these troubles, but introduce a new one. The proximity of the grid, heater and plate contacts on the valve socket make for severe leakage and capacitance requirements of the valve base and socket. Thus, if leakage were the only consideration the insulation resistance between control grid and heater pins, in order to realise the above noise level, would need to be of the order of 50,000 megohms if the grid circuit impedance were 0.1 megohm.

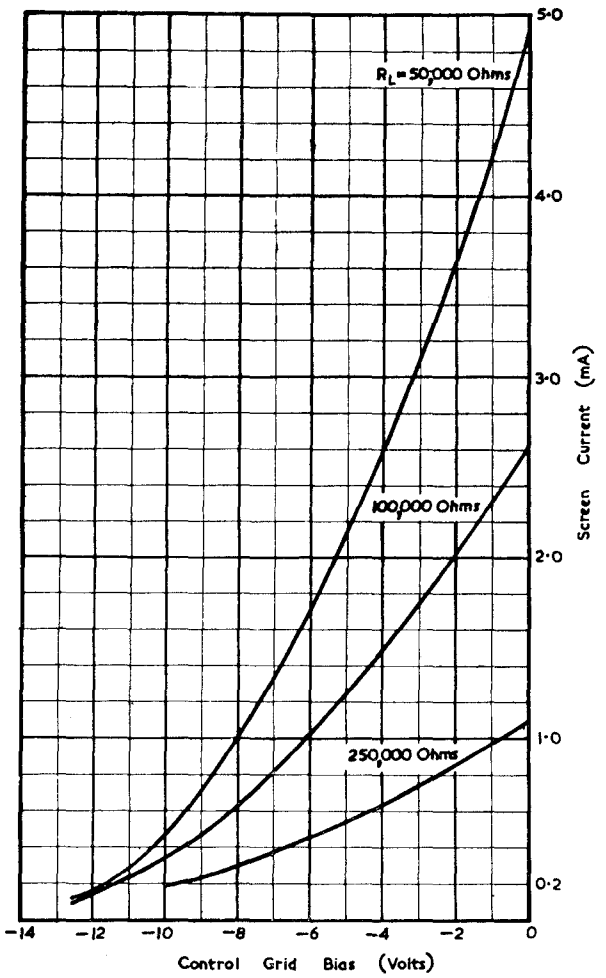



*Fig. 2.—Curves of 6AU6 screen current vs. control grid bias ($E_p = E_{c3} = 0$) with different load resistors.*

However, by using the guard ring principle satisfactory attenuation can be achieved more readily, and if, for instance, earthed contacts and the earthed centre spigot can be arranged to isolate the heater contacts from the grid and plate contacts, then hum problems due to leakage are greatly minimized. It is assumed in such cases that neither side of the heater winding is earthed, as centre tapping is usually necessary to reduce the hum level to a minimum.

Figure 1 shows, that with the triode connection mentioned in Radiotronics No. 139 (grid Nos. 2 and 3, plate and shield connected together), there is no low impedance connection to ground between grid 1 and heater, so that hum trouble in the grid circuit is possible. By earthing pin 2 (the suppressor) this trouble may be overcome, but under the recommended triode operating conditions, this leads to the maximum rating for the screen dissipation being exceeded in some valves. In addition, with pin 2 earthed, the leakage from heater to pins

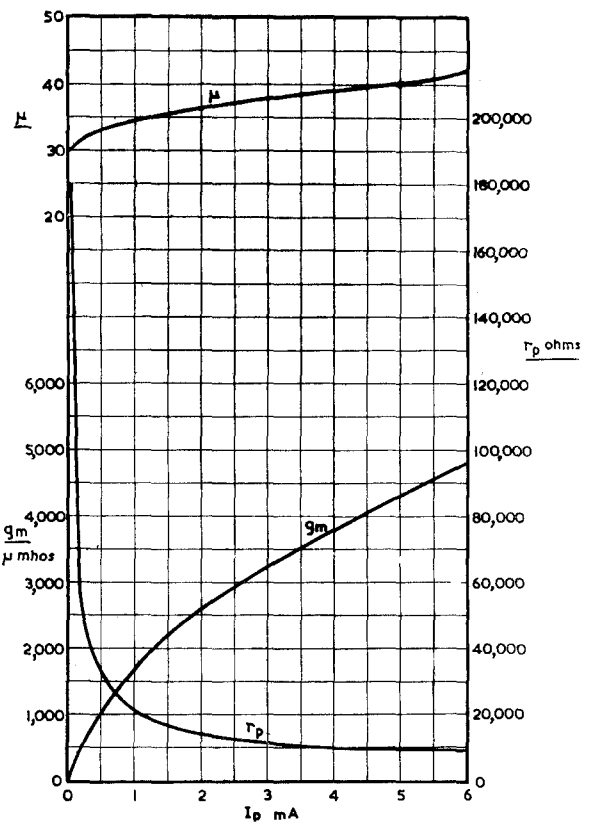



*Fig. 4.—Curves of 6AU6 μ, $g_m$ and $r_p$ vs. $I_p$ connected with grid No. 2 used as plate and with ($E_p = 100V$, $E_{c1}$ varied). The valve is triode grid No. 3 and the pentode plate earthed.*

5 and 6 (triode plate) is unbalanced and will be troublesome at low signal levels. Leakage in the 6AU6 itself will not be serious because its base material is glass, and in this respect it is an improvement over previous types with moulded bakelite bases (particularly single-ended types), but the insulation requirements for the socket will still be severe.

A recommended method of operating the 6AU6 as a pre-amplifier to overcome these troubles is to use grid 2 as the triode plate, with grid 3, the pentode plate and the external shield grounded. This gives an earthed contact on either side of the

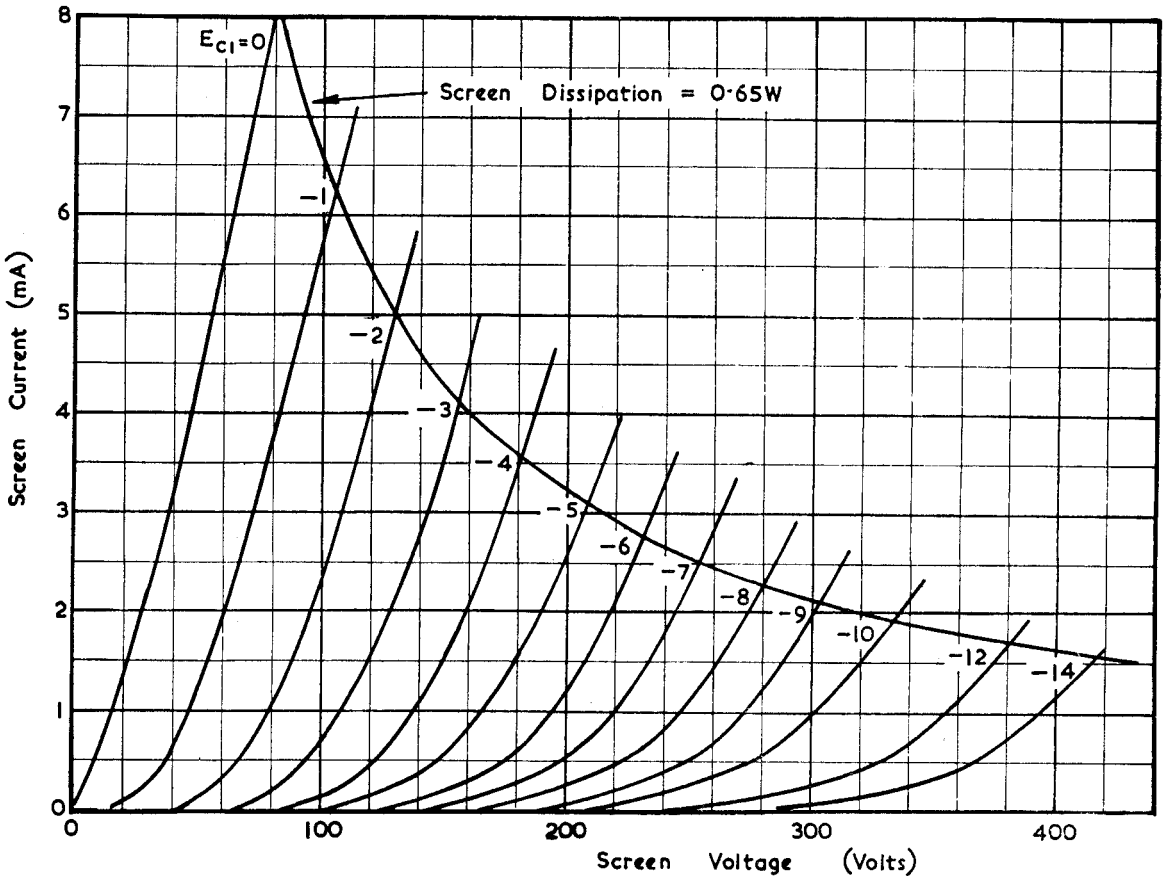



*Fig. 3.—Curves of 6AU6 screen current vs. screen voltage for fixed values of grid No. 1 bias ($E_p = E_{cs} = 0$).*

heater pins and the plate contact, while the grid has an earthed contact on one side and the cathode on the other.

Triode connection is desirable for a pre-amplifier because triodes are inherently less noisy than pentodes, firstly because of their higher $g_m/\sqrt{I_b}$ ratio and secondly because there is no noise due to random division of current between plate and screen.

The linearity of the mutual characteristic of grid 2 used as the plate is good, as indicated in Fig. 2. in which the dynamic characteristic for three different resistive plate loads is shown.

There are, however, two disadvantages of this method of connection. Firstly, the screen grid dissipation must not exceed 0.65 watt, which may restrict a transformer or choke-coupled design, and secondly, at high output levels distortion is higher than with the standard triode connection. This grounded-plate connection is accordingly recommended only for low level pre-amplifier use.

Figure 3 gives the plate characteristic of the 6AU6 operated in this manner, and Figure 4 shows $\mu$, $g_m$ and $r_p$ as a function of plate current.

Some typical operating conditions are set out below.

**Typical Conditions**

| | | | |
|---|---|---|---|
| **$E_{bb}$ = 300V.** | | | |
| $R_L$ (Megohms) | 0.05 | 0.1 | 0.25 |
| $R_K$ (Ohms) | 230 | 450 | 1,000 |
| $I_b$ (mA) | 4.3 | 2.35 | 1.0 |
| Stage gain* | 25 | 25 | 23 |
| **$E_{bb}$ = 180V.** | | | |
| $R_L$ (Megohms) | 0.05 | 0.1 | 0.25 |
| $R_K$ (Ohms) | 450 | 750 | 1,600 |
| $I_b$ (mA) | 2.4 | 1.3 | 0.59 |
| Stage Gain* | 21 | 23 | 21 |
| **$E_{bb}$ = 90V.** | | | |
| $R_L$ (Megohms) | 0.05 | 0.1 | 0.25 |
| $R_K$ (Ohms) | 1,100 | 2,000 | 4,000 |
| $I_b$ (mA) | 0.93 | 0.54 | 0.25 |
| Stage Gain* | 14 | 14 | 13 |

* Resistance of following grid leak = 0.5 megohm.