PHILIPS 4060 ELECTROMETER TRIODE

Description and Application Note

The electrometer triode is an electronic device with minimum grid currents designed for laboratory work involving the measurement of small electrical quantities. To ensure a high degree of insulation, a special form of electrode assembly has been adopted, and is shown in Fig. 1. The anode is a flat rectangular electrode mounted horizontally above the glass pinch. The filament comprises two straight sections mounted immediately over and parallel to the anode. The grid takes the form of another metal rectangle, which in turn is mounted directly over the filament. The filament and anode leads are taken down through the pinch and joined to the valve pins in the normal manner. The grid, however, is supported by means of long glass rods built into the bulb and the lead is taken out through the top of the bulb to a grid cap.

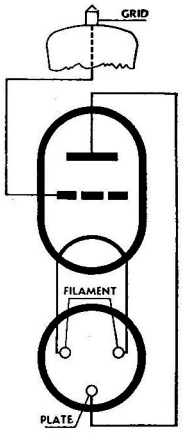
In the 4060 the total grid current is in the order of 10^{-14} to 10^{-15} amps. This condition can only be achieved by sacrificing other characteristics, and for this valve the amplification factor is 0.5 to 1 and the average slope is 0.028 mA/V.

In view of these special ratings, it will be realised that the electrometer triode will serve for laboratory purposes only, and it may be used to advantage for quantitative measurements in the following applications:—

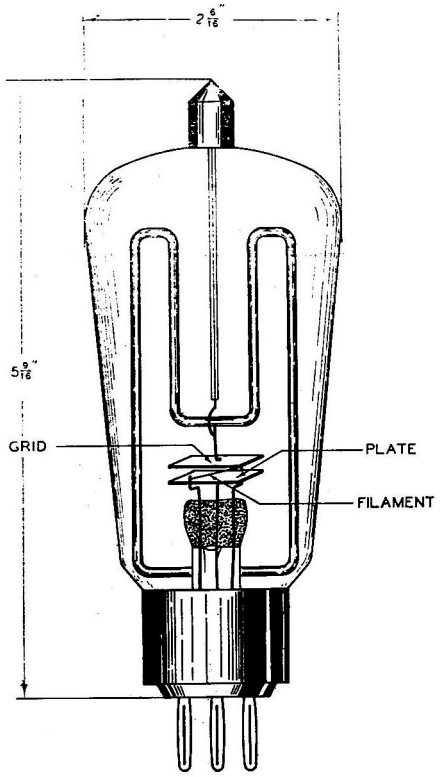
(1) Hydrogen ion activity (pH measurements).
(2) Measuring small light intensities (Photo electric currents).
(3) Ionisation currents.
(4) Counting Alpha and Beta particles in experiments with radio active material.
(5) X-ray work.
(6) Applied physics and electro-medical experiments.

In order to limit the grid current to the values already given, precautions not met with in ordinary valve construction must be taken. Consequently, it is interesting to note the plate voltage is of a low order (4 volts only) to eliminate the possibility of positive ions leaving the anode and flowing to the grid, thus producing grid current. Likewise, a negative potential is applied to the grid, despite the low plate voltage, in order to further minimise grid current.

The bulb of the 4060 is clear glass, due to the "getter" being applied below the pinch to maintain the high insulation.



Philips 4060, socket connections viewed from bottom of base.
Fig. 2.



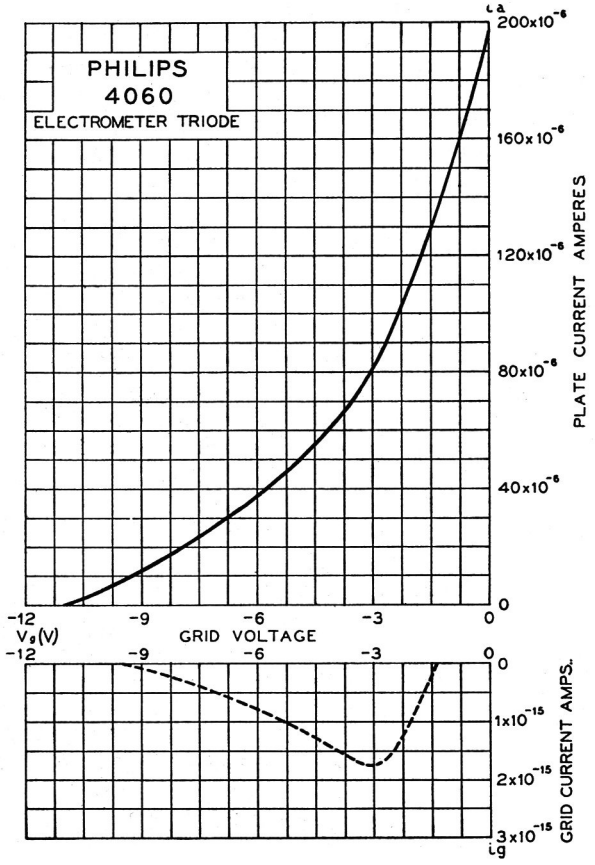
Constructional details of Philips 4060 Electrometer Triode.

Fig. 1.

CHARACTERISTICS: PHILIPS 4060 ELECTROMETER TRIODE

Filament Voltage	0.5 to 0.7 volts
Filament Current	1.0 ampere
Plate Voltage	4.0 volts
Neg. Grid bias	2.5 volts
Amplification factor	0.5 to 1
Mutual conductance (at —2.5 volts bias)	.028 mA/V.
Maximum grid current	10^{-14} Amps.
BASE:	3 pin English

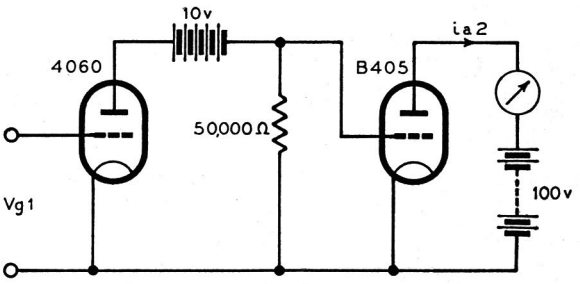
NOTE: Valves are individually calibrated for filament voltage.



Average characteristics
Fig. 3.

APPLICATION

The bulb of the 4060 must be kept clean and dry, and the surrounding air should be dried by the use of a desiccator. It is also important to guard against photo-electric currents, and for this reason it is recommended that the 4060 be mounted in a special "dark box." The plate voltage must never exceed 6 volts, and should preferably be adjusted to 4 volts. Average characteristics for this voltage are given in Fig. 3.



Recommended circuit diagram wherein the B405 is used as an amplifier in conjunction with the 4060.
Fig. 4.

For potential measurements a compensated galvanometer may be connected to the plate circuit. Fig. 4 shows a recommended circuit arrangement which will have a mutual conductance equal to

$$\frac{d\ Ia2}{d\ Vg1} = 0.1\ \text{mA/V. (approx.)}$$

measured between current in output circuit and voltage applied to input circuit.