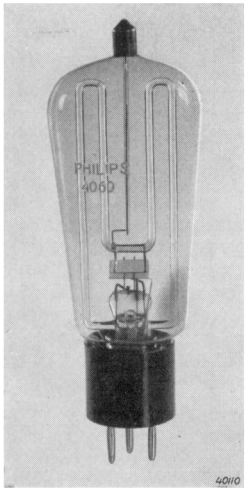
PHILIPS "Miniwatt" SPECIAL VALVES

ELECTROMETER TRIODE 4060



CHARACTERISTICS

Heater voltage	V_f	= 0·7 V
Heater current	I_f	= 0·6 A
Anode voltage	V_a	= 4 V
Slope	S	= 28 μA/V
Grid current	I_g	< 10^{-14} A
Maximum anode voltage	$V_{a\,max}$	= 6 V

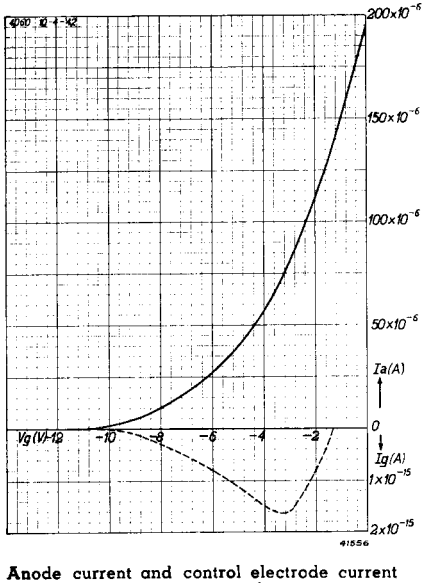
DESCRIPTION

The 4060 valve is an electrometer-triode especially useful for measuring voltages. It permits such measurements to be made without drawing even the smallest current from the voltage source, in circuits of very high resistance, for example, or in those where for some other reason the drawing of current would precipitate a variation of voltage. When very small electrical quantities are being dealt with, such variations are particularly prone to occur. Instruments like electroscopes and the quadrant electrometers of Thomson and Mascart may be used, but they are very expensive, and moreover elaborate precautions are necessary if accurate results are to be obtained; in addition such instruments are unsuitable for portable industrial gear.

The circuit in which the 4060 valve is used is similar to that of a triode voltmeter. The voltage to be measured is applied to the control electrode, and measuring apparatus is connected in the anode circuit to show the current variations.

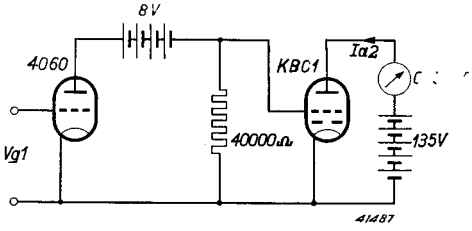
The ordinary valve voltmeter, however, is unsatisfactory for the applications mentioned above. Whereas in the case of an electrometer the current drawn by the apparatus depends only on the insulation of the various parts, in measuring gear using a thermionic valve the magnitude of the current depends on:

insulation of the control grid;
grid current;
grid emission due to heating by the filament;



Anode current and control electrode current against negative bias.

photo-electric emission from the grid, due to illumination by the filament and by light sources outside the valve; ionic current due to ionising of residual gas.



Circuit for the 4060, using a KBC 1 as DC amplifier

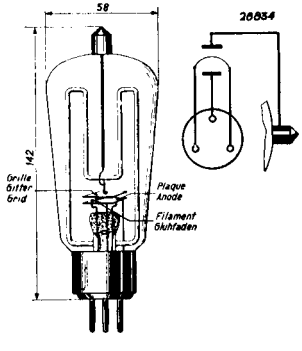
In a normal receiving valve, grid current is of the order of 2×10^{-7} A, which is too high for the applications being considered. In the 4060 tube a special construction and other precautions have made it possible to reduce the control-electrode current to about 2×10^{-15} A. This result has been achieved by the following measures:

The control electrode, of the same shape as the anode, hangs on two glass rods some 10 cm long, and the lead is taken to a top cap; thereby very good insulation of the control electrode is ensured. The filament, which is run at a very low temperature, is situated between the control electrode and the anode; thus cathode emission to the control electrode, as well as emission from the lat e s minimised. Furthermore, this layout keeps photo-electric emission from .h' control electrode at a low and constant figure; the tube should be mounted in a small opaque box to protect it from external illumination. The application of a very low anode voltage minimises the ionic current; slope is accordingly low. However, it is a simple matter to add an amplifying stage and so obtain bigger current variations; a KBC 1 valve may be arranged as in the circuit shown above.

Among the fields in which the 4060 tube may usefully be employed are:

1. electro-chemical applications, suchs as determination of pH;
2. Photometry; measuring the brightness of stars, for instance, and investigating spectral rays;
3. measurement of very small electrical quantities, such as are encountered in the investigation of radio-activity and cosmic rays.

The figures quoted for filament voltage and current are approximate only: the precise values are specified for every valve.



Arrangement of electrodes, connections and maximum dimensions in millimetres.