Audio-Frequency Applications of Type 6BE6

When used as an a-f amplifier the 6BE6 has two grids to which a signal can be applied, and for fader-mixer applications it is therefore a useful valve, needing no additional isolating resistors—with their resultant halving of available gain—to reduce interaction of controls.

In addition, with a signal applied to grid 3 the gain obtained from the valve can be varied over a wide range by means of a bias applied to grid 1. This characteristic may be used for volume expansion or in circuits in which it is desired to control gain by electronic means.

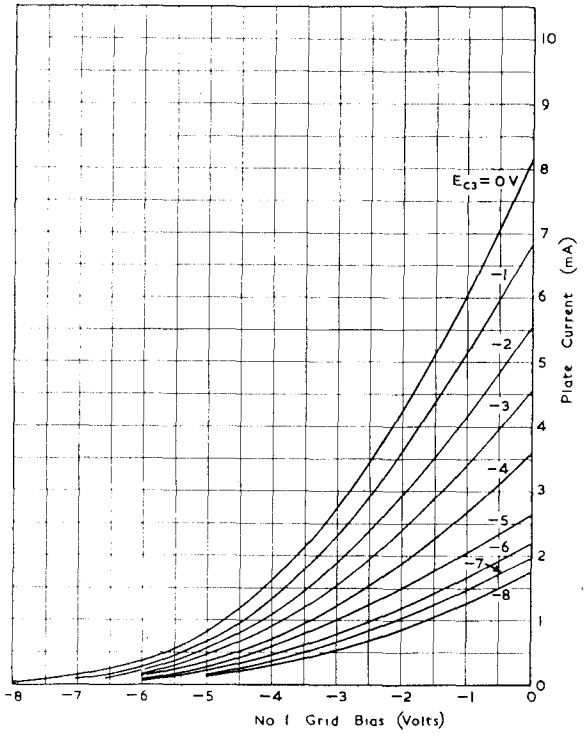

Figure 1. Curves of 6BE6 plate current vs. No. 1 grid bias for fixed values of No. 3 grid bias, E_b = 250V; $E_{c2\ and\ 4}$ = 100V.

Figure 1 gives the grid 1 voltage vs. plate current static characteristic of the 6BE6 for different grid 3 voltages, and Figure 2 the grid 3 voltage vs. plate current curves for different grid 1 voltages. For operation over comparatively small plate current excursions the linearity is good, as indicated by the distortion figures shown in Tables I and II.

Figure 3 shows a fader-mixer circuit which gives a gain of 62 from the grid 1 input and 25 from the grid 3 input. Values of measured distortion vs. output voltage for the circuit are as stated; these figures, however, include the a-f generator distortion, which was about 0.1%, so that the distortion from the 6BE6 at low output voltages is actually less than the tables show. At high output voltages most of the distortion is second harmonic.

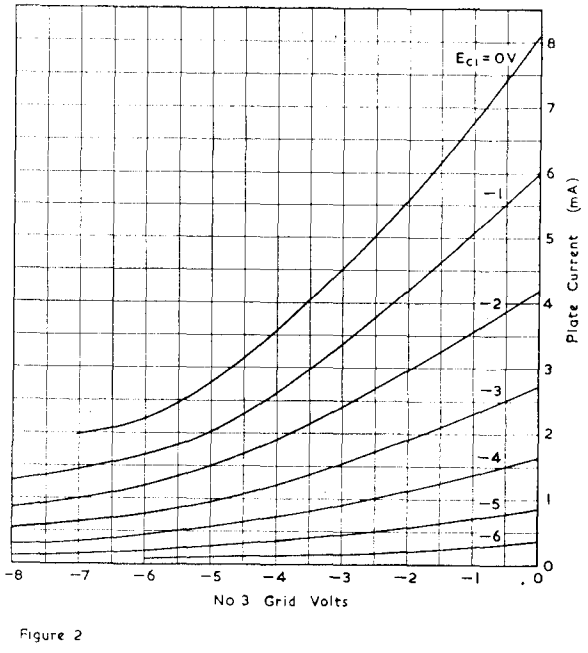

Figure 2. Curves of 6BE6 plate current vs. No. 3 grid bias for fixed values of No. 1 grid bias. E_b = 250V; $E_{c2\ and\ 4}$ = 100V.

TABLE I. — Input to grid 1.

Output (volts r.m.s.)	1	5	10	20.
Distortion (%)	0.16	0.19	1.3	3.0

TABLE II. — Input to grid 3.

Output (volts r.m.s.)	1	5	10	20.
Distortion (%)	0.14	1.4	2.6	3.9

Contributed by the Circuit Design Laboratory Valve Works, Ashfield.

The values of the components in Figure 3 are not critical and a reduction of the plate load from 100,000 to 50,000 ohms merely reduces gain to rather more than half the original figure, with a similar reduction of distortion. Higher values of the plate load resistance are not recommended as the distortion becomes excessive. Increasing the value of the bias resistor also decreases gain and distortion proportionately, a 1,000 ohm bias resistor giving about two-thirds of the gain and distortion quoted for 500 ohms. Bias can be obtained by any of the usual methods. Where self-bias is used, the high transconductance of the 6BE6 makes the use of a large cathode by-pass necessary if good low-frequency response is required.

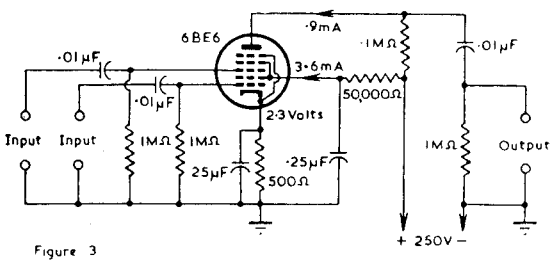

Figure 3. Audio-frequency fader-mixer circuit using type 6BE6.

The screen voltage should not exceed 100 volts, but is not otherwise critical.

For electronic gain control purposes, it is advisable to apply the signal to grid 3 and the control voltage to grid 1. If the signal is applied to grid 1 distortion becomes excessive as the control voltage on grid 3 is increased. In order to determine the range of control available with the signal applied to grid 3 an input of 0.8 volt r.m.s. was used in the circuit of Figure 3 and the bias applied to grid 1 was varied, with the following results:—

TABLE III.

Output (volts r.m.s.)	20	2	0.2	0.02	0.002
Grid 1 bias (volts)	0	−11	−19	−23	−25

With a grid 1 bias of −11 volts the distortion decreased from 3.9 to 2.5%. At lower output levels distortion readings could not be made, and the signal could not be increased greatly without signal grid current flowing. However, at the lower output levels it is unlikely that distortion would increase.

Many applications of these characteristics of the 6BE6 are possible. The measurements tabulated were made on a bogie* valve, but as the characteristics in question are not controlled by the valve specification and are not normally tested in production, it is to be expected that some variation will be experienced from valve to valve.

***A valve having standard characteristics.**