Title
CASCODE AMPLIFIER CHARACTERISTICS

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Publication Date
1955-07-27

UNIVERSITY OF CALIFORNIA

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BERKELEY, CALIFORNIA

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UCRL-3069

UNIVERSITY OF CALIFORNIA
Radiation Laboratory
Berkeley, California

Contract No. W-7405-eng-48

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July 27, 1955

Printed for the U.S. Atomic Energy Commission

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In a pentode amplifier application it is frequently desirable to use two triode sections arranged in cascode. Approximate static characteristics, usually needed in the design calculations, can be found very quickly from the corresponding characteristics of the triode under consideration.

Figure 1 illustrates a circuit that might be used to determine the static characteristics experimentally. Given a value of the upper grid voltage, E_{c2}, one can determine a family of E_b-I_b curves with E_{c1}, the bias voltage, as a parameter. These will appear to be similar to pentode characteristics, but with some important differences.

Assume E_{c1} and E_{c2} fixed for the moment. As E_b is increased to sufficiently large values, E_{b1} will increase until it approaches E_{c2}, at which time it will level out to a value very near E_{c2} because of the clamping action of the upper triode. I_b will also level out to a saturation value I_b' corresponding to $E_{b1} \cong E_{c2}$. As E_b is reduced to sufficiently low values, the upper triode goes into grid conduction and the voltage E_{b2} is determined from the zero bias curve for the particular I_b.

Once E_{c2} is set, then the cascode characteristic corresponding to a particular E_{c1} can be derived by determining E_{b1} on the $\underline{E_{c1}}$ bias triode line, and E_{b2} on the <u>zero</u> bias triode line, both as a function of I_b up to the saturation level I_b'.

An example is given in Fig. 2 for the 6BC4. E_{c2} is given as 150 volts. For the particular curve shown in detail $E_{c1} = -1$ volt. $I_b' = 20.5$ ma is shown as the value of I_b when $E_{b1} = E_{c2} = 150$ volts. The point "x" is obtained for $I_b = 15$ ma. E_{b1} is defined by the triode curve to be 132 volts at this point. Since the upper triode is in grid conduction, E_{b2} from the zero bias curve is 93 volts. $E_b = E_{b1} + E_{b2}$ then is shown on the point "x" as 225 volts. Other points obtained in the same manner are shown and a continuous line is drawn through these and folded over at the knee to meet the I_b' line. Other curves for the family $E_{c2} = 150$ volts can be drawn but are not shown here.

Characteristics obtained in this manner are not precise but should be well within the limits of the manufacturer's tolerances on g_m, etc. The upper grid

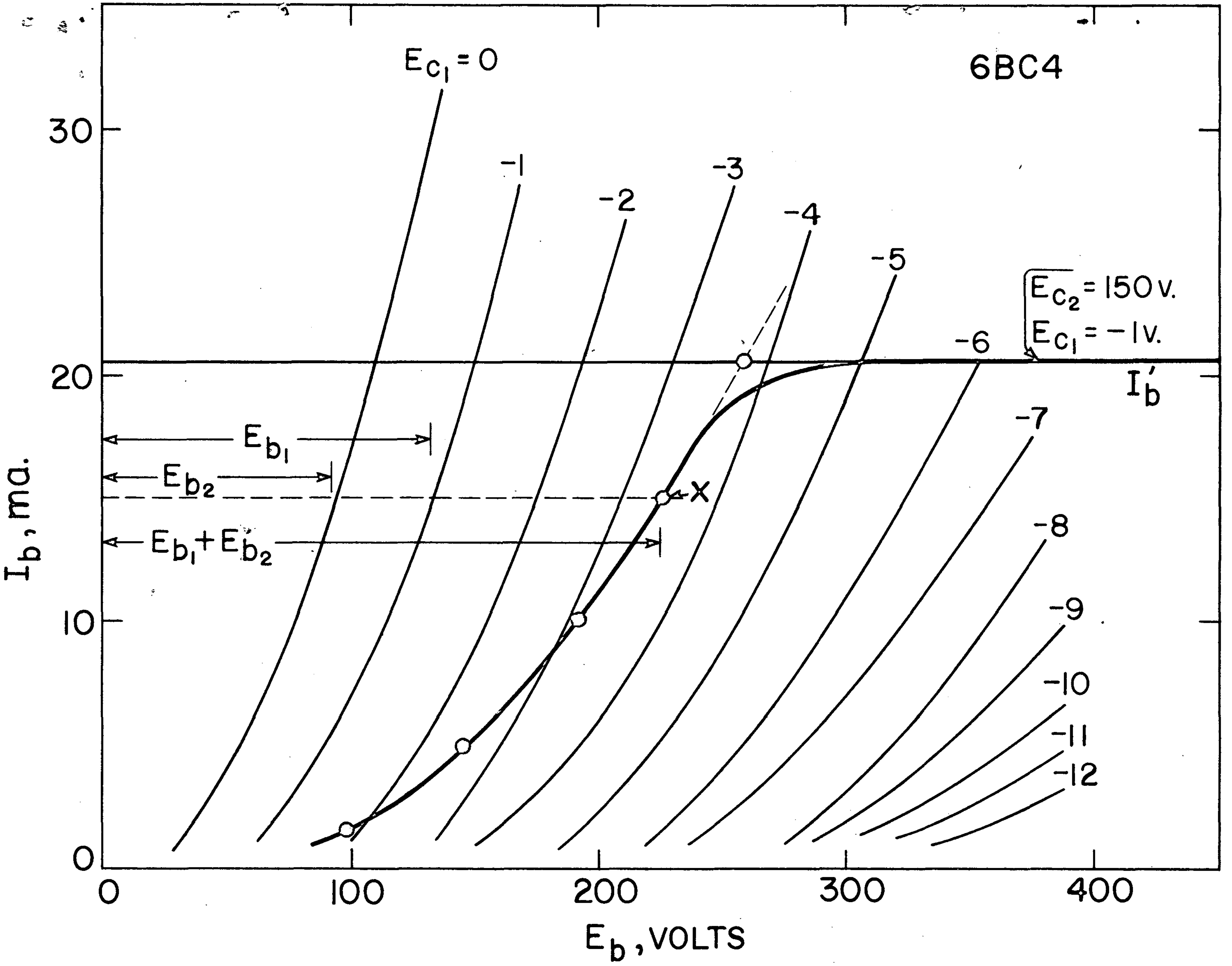
6BC4
$E_{c_1} = 0$
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
$E_{c_2} = 150$ v.
$E_{c_1} = -1$ v.
I_b'
E_{b_1}
E_{b_2}
$E_{b_1} + E_{b_2}$
X
I_b, ma.
E_b, VOLTS
0
10
20
30
0
100
200
300
400

Fig 1

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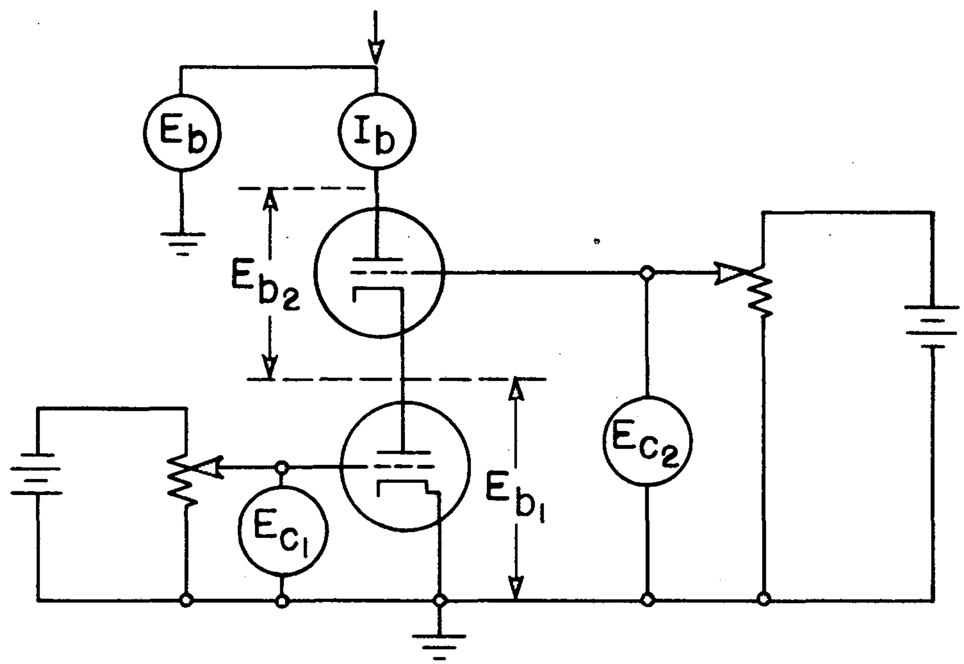

Fig 2

24081-1

circuit may act as a plate load for the lower tube and tend to shift the lower part of the cascode curve in Fig. 2 to the left. In addition I_b should approach I_b' gradually -- more so with low-μ tubes.

Increasing E_{c2} has the effect of spreading out the cascode curves vertically and thus increasing the g_m; however, the knee will be shifted to the right and higher plate-supply voltages are required to get into the "pentode" region.

The I_b' saturation lines are usually the ones of primary interest. These can be found quickly by the intersection of the $E_b = E_{c2}$ line with the triode curves. The knee can be located approximately by assuming grid conduction at I_b' and marking off $E_b = E_{b1} + E_{b2}$ as before. Determining one knee should be sufficient, as the others occur at about the same voltage.

This work was performed under the auspices of the U.S. Atomic Energy Commission.
