RCA MANUFACTURING COMPANY, INC.
A RADIO CORPORATION OF AMERICA SUBSIDIARY
Harrison, New Jersey

RCA RADIOTRON
DIVISION

APPLICATION NOTE No.57
February 5, 1936.

APPLICATION NOTE ON THE 6L7 AS AN R-F AMPLIFIER

Although the primary use of the 6L7 is as a mixer tube in superheterodyne receivers, this tube can be used advantageously as an r-f or i-f amplifier. The 6L7, an all-metal type, includes a heater, a cathode, five grids, and a plate. Two of the five grids are control grids, two are screens, and one is a suppressor, which is internally connected to the cathode. The signal is applied to control grid G_1, which has a remote cut-off characteristic; the other control grid (G_3), interposed between the two screens, is biased negatively, and has a sharp cut-off characteristic.

When the pentode type of remote cut-off tube now in general use is under the control of the a-v-c system, relatively large signals can be handled without introducing modulation distortion and cross modulation effects. As the carrier voltage applied to such a tube increases, the transconductance, and hence the gain, decreases, because of the action of the a-v-c system. When the carrier voltage is large enough, further increases in carrier voltage are offset by the decrease in gain due to the a-v-c system; the overall response of the receiver is then substantially independent of further increases in carrier voltage. The a-v-c voltage at which the response begins to become independent of carrier strength depends on the number and type of tubes under the control of the a-v-c system. A curve which shows the relation between audio output and carrier input voltage describes the a-v-c characteristic of a receiver up to the point at which overloading occurs.

The usual a-v-c characteristic rises at first sharply with increases in carrier voltage and then flattens out with further increases in carrier voltage. For the remote cut-off type of r-f pentode now in use, the region in which the a-v-c characteristic begins to flatten can occur at a reasonable low carrier voltage in a receiver of nominal sensitivity. The flat portion of the curve, however, may not be sufficiently horizontal to prevent overloading of the audio system when a strong local station is tuned in. Furthermore, an a-v-c characteristic that rises too rapidly cannot satisfactorily compensate for fading.

It is not desirable to have a horizontal a-v-c characteristic if tuning the receiver to the carrier frequency is to be simple. When a receiver having a perfectly flat a-v-c characteristic is tuned slightly off resonance, a tuning indicator which is operated from the a-f diode will not show a change in signal strength. The a-v-c characteristic should be a choice between that required for easy tuning and that necessary to minimize overloading and fading.

The a-v-c characteristic of a receiver can be improved by increasing the number of tubes under the control of the a-v-c system or by amplifying the a-v-c voltage before applying it to the controlled tubes. These expedients, however, because they increase the cost of the receiver, cannot always be employed. The use of one or more type 6L7 tubes offers a good solution for the problem of obtaining a desirable a-v-c characteristic at limited cost.

When the 6L7 is used as an r-f or i-f amplifier, the signal should be fed to G_1; the a-v-c voltage should be applied to both control grids (G_1 and G_3) in order to reduce the transconductance of the tube to a minimum with a small a-v-c voltage. Referring to the dotted curve of Fig. 1, it may be seen that approximately 15 volts of a-v-c voltage is required for a G_1-P transconductance (g_{m1}) of 5 micromhos when $E_{c1} = E_{c3}$. This should be compared to the 40 volts necessary for g_{m1} = 10 micromhos for a typical remote cut-off pentode. Cut-off at a correspondingly low voltage may be obtained, of course, by merely using a tube having a single sharp cut-off control grid, such as the 6J7; but the use of such a tube will result in severe modulation distortion and cross modulation effects, especially with large input signals. An examination of the transconductance curves of Fig. 1 shows that a comparatively large signal can be applied to the No. 1 control grid of a 6L7 before distortion due to the curvature of the characteristic becomes appreciable. The 6L7 as an r-f or i-f amplifier, therefore, has the a-v-c characteristic heretofore peculiar only to sharp cut-off tubes and at the same time retains the remote cut-off features of the super-control tube.

The 6L7 can be employed in receivers developing more than 15 volts of a-v-c voltage. In this case, the a-v-c resistor can be tapped at the point necessary to furnish 15 volts to both control grids of each 6L7; additional a-v-c voltage may then be distributed to the remaining amplifier and mixing tubes.

It is not necessary that the same a-v-c voltage be applied to both control grids of the 6L7. The voltage applied to G_3 may be a fraction of that applied to G_1 when a less rapid change in gain with a-v-c voltage is desired. Thus, an unequal distribution of voltage on the control grids of one or more 6L7 tubes is effective in realizing a desired a-v-c characteristic. Referring to Fig. 1, it is seen that the dotted line shows the most rapid change in gain with a-v-c voltage; this occurs when $E_{c1} = E_{c3}$. The solid curves show the change in gain with a-v-c voltage when G_3 has the fixed biases shown. The change in transconductance for any ratio (R) of E_{c3} to E_{c1} can be determined from Fig. 1 by joining the points of intersection of E_{c1} and $E_{c3} = RE_{c1}$.

Since the transconductance of the 6L7 can be reduced to 5 micromhos with 15 volts of a-v-c voltage, and since the 6L7 is capable of responding to comparatively strong signals with little distortion, this tube may be employed successfully as the i-f amplifier tube in a receiver having only one stage of i-f. Such a receiver can be made to have a fairly flat a-v-c characteristic and respond to strong local stations without introducing excessive distortion.

Characteristics of the 6L7 as an Amplifier

Heater Voltage	6.3	Volts
Heater Current	0.3	Ampere
Plate Voltage	250 max.	Volts
Screen Voltage	100 max.	Volts
Grid No.1 Voltage	-3 min.	Volts
Grid No.3 Voltage	-3 min.	Volts
Plate Current	5.3	Milliamperes
Screen Current	5.5	Milliamperes
Plate Resistance	0.8	Megohm
Transconductance (G_1-P)	1100	Micromhos
Transconductance with -15 volts (approx.) on Grids No.1 and No.3	5	Micromhos

RCA Cunningham Radiotron RADIO TUBES

RCA-6L7

AVERAGE CHARACTERISTICS

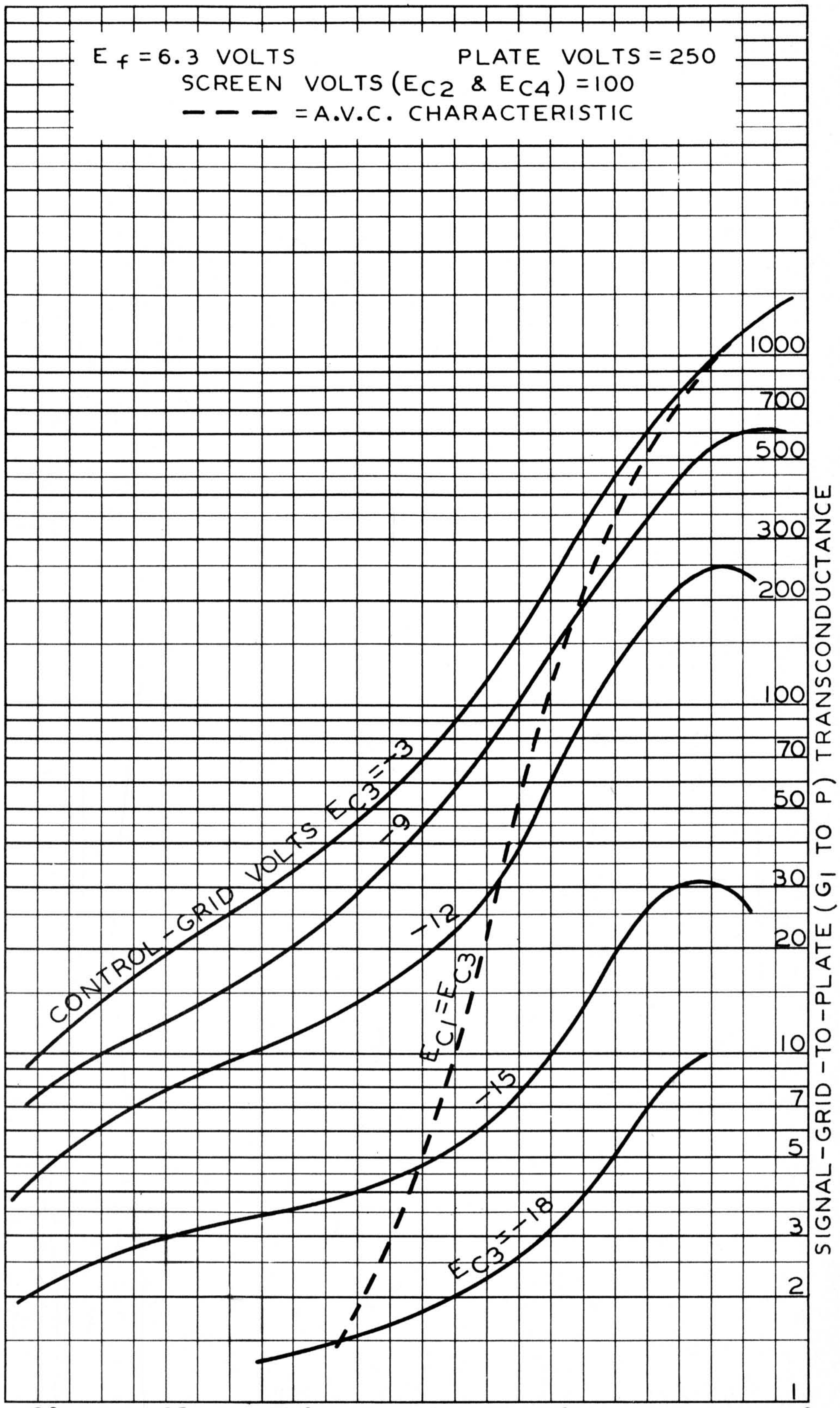

FIG. 1

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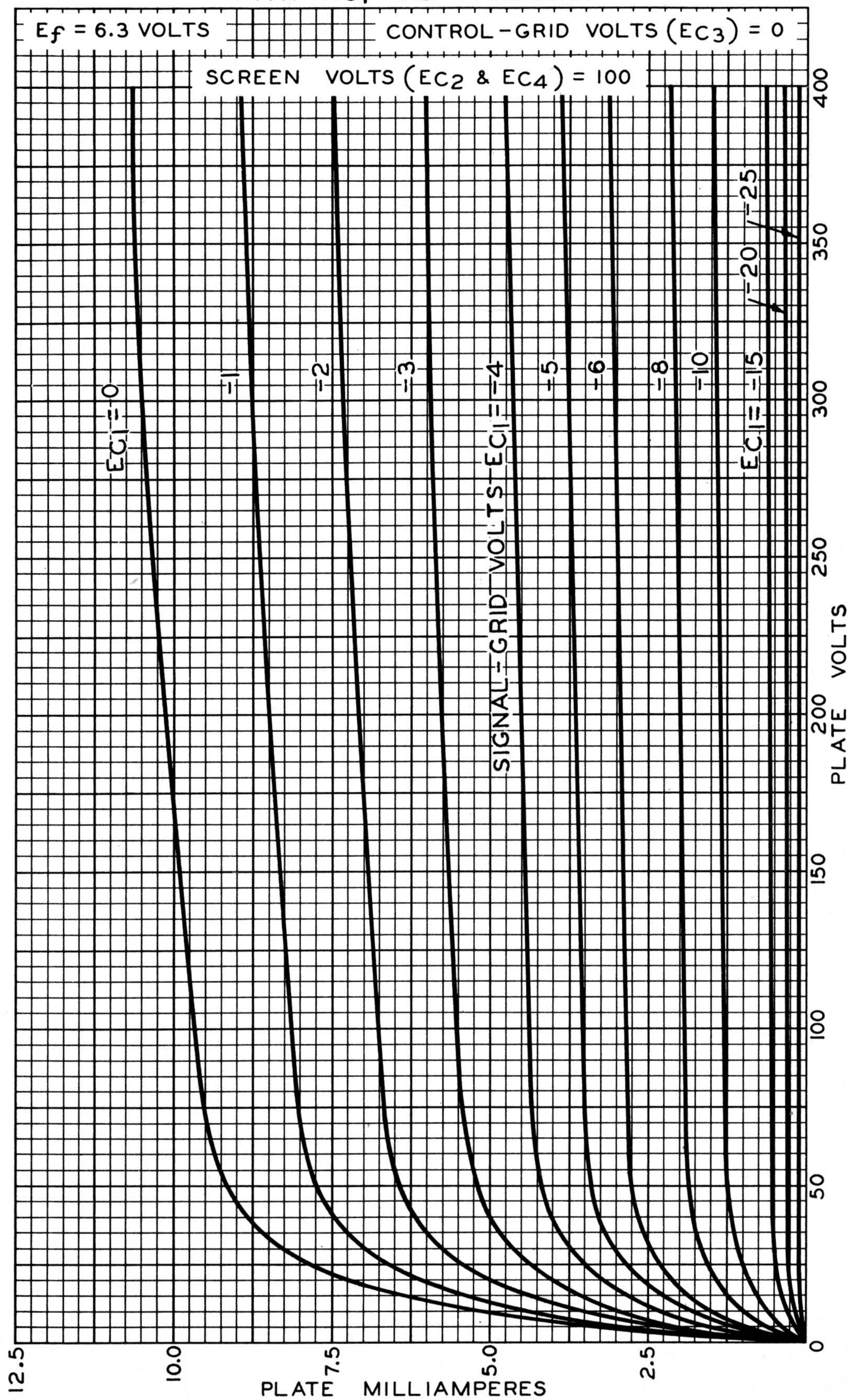
RCA Cunningham Radiotron RADIO TUBES

RCA-6L7

AVERAGE PLATE CHARACTERISTICS
WITH E_{C1} AS VARIABLE



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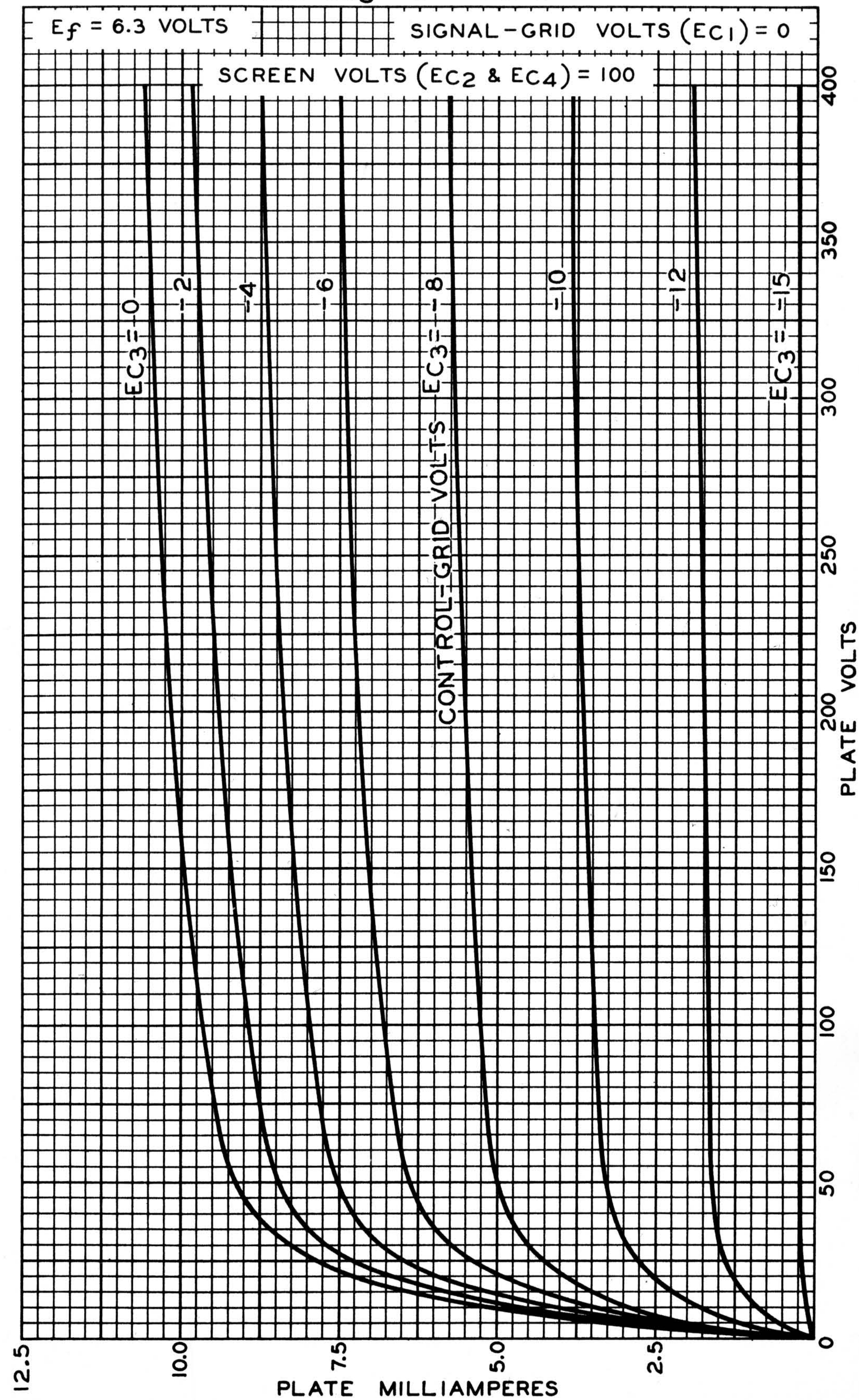
Cunningham Radiotron

RCA-6L7

AVERAGE PLATE CHARACTERISTICS
WITH E_{C3} AS VARIABLE



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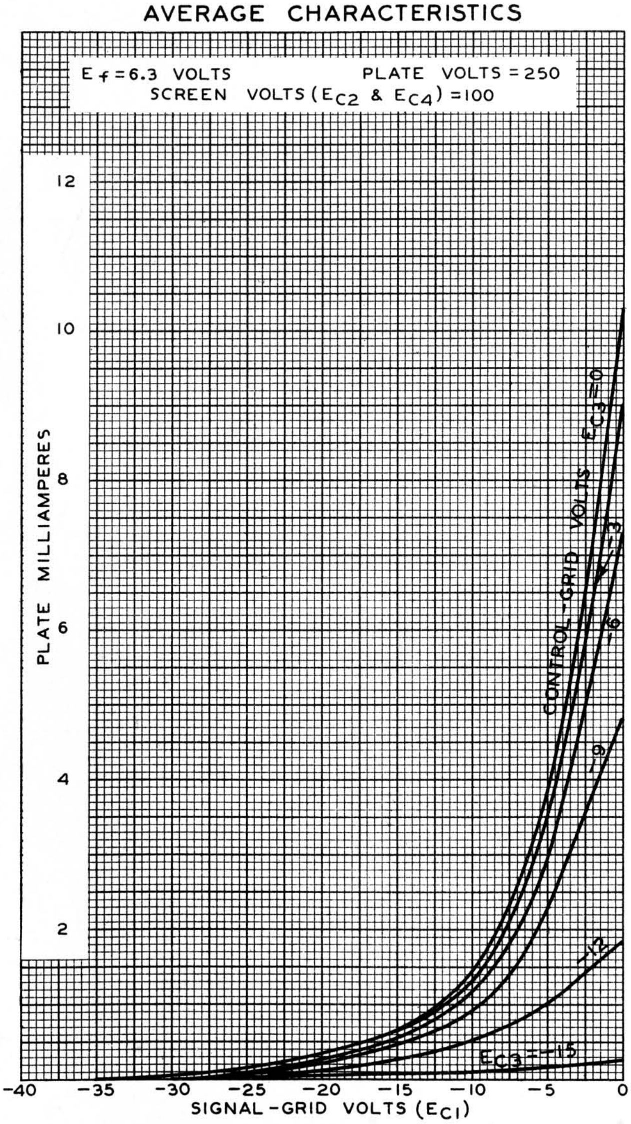
RCA Cunningham Radiotron RADIO TUBES

RCA-6L7

AVERAGE CHARACTERISTICS



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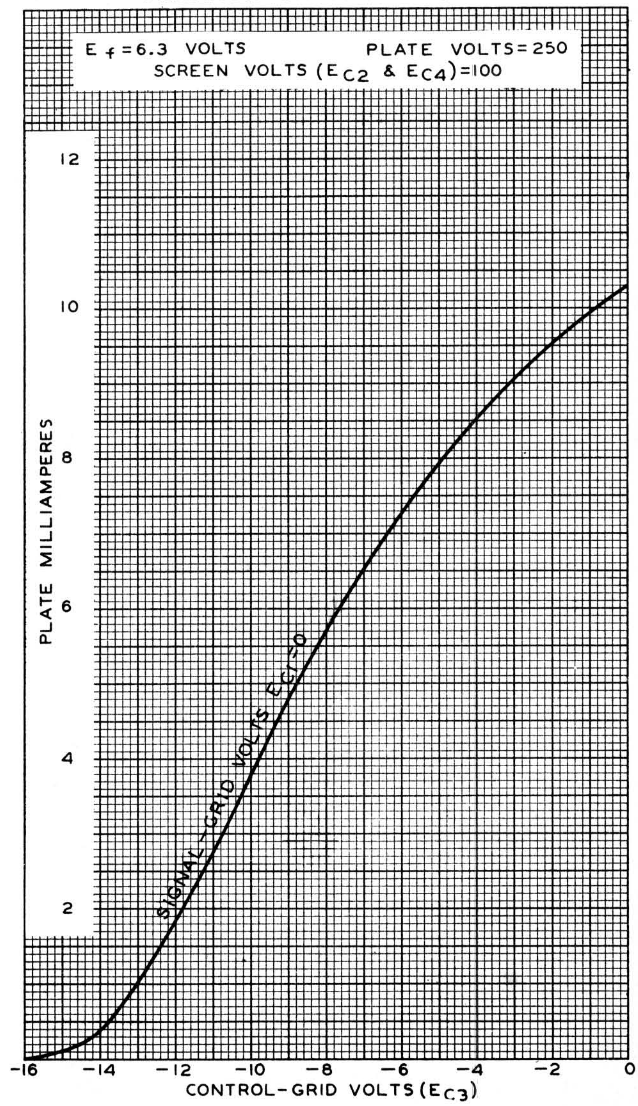
RCA Cunningham Radiotron RADIO TUBES

RCA-6L7

AVERAGE CHARACTERISTIC



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