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

Although the primary use of the 6L7 is as a mixer tube in super-
heterodyne 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 G1, which has a re-
 mote cut-off characteristic; the other control grid (G3), interposed be-
tween the two screens, is biased negatively, and has a sharp cut-off char-
acteristic.

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 substan-
tially 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 re-
ceiver up to the point at which overloading occurs.

The usual a-v-c characteristic rises at first sharply with in-
creases 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 sensi-
tivity. The flat portion of the curve, however, may not be sufficient-
ly 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 G₁; the a-v-c voltage should be applied to both control grids (G₁ and G₃) 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 G₁-P transconductance (εₘ₁) of 5 micromhos when Eₒ₁ = Eₒ₃. This should be compared to the 40 volts necessary for εₘ₁ = 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 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 G₃ may be a fraction of that applied to G₁ 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 Eₒ₁ = Eₒ₃. The solid curves show the change in gain with a-v-c voltage when G₃ has the fixed biases shown. The change in transconductance for any ratio (R) of Eₒ₃ to Eₒ₁ can be determined from Fig. 1 by joining the points of intersection of Eₒ₁ and Eₒ₃ = REₒ₁.
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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater Voltage</td>
<td>6.3 Volts</td>
</tr>
<tr>
<td>Heater Current</td>
<td>0.3 Ampere</td>
</tr>
<tr>
<td>Plate Voltage</td>
<td>250 max. Volts</td>
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<tr>
<td>Screen Voltage</td>
<td>100 max. Volts</td>
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<tr>
<td>Grid No.1 Voltage</td>
<td>-3 min. Volts</td>
</tr>
<tr>
<td>Grid No.3 Voltage</td>
<td>-3 min. Volts</td>
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<tr>
<td>Plate Current</td>
<td>5.3 Milliamperes</td>
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<tr>
<td>Screen Current</td>
<td>5.5 Milliamperes</td>
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<tr>
<td>Plate Resistance</td>
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<tr>
<td>Transconductance (G&lt;sub&gt;1-P&lt;/sub&gt;)</td>
<td>1100 Micromhos</td>
</tr>
<tr>
<td>Transconductance with -15 volts (approx.) on Grids No.1 and No.3</td>
<td>5 Micromhos</td>
</tr>
</tbody>
</table>
AVERAGE CHARACTERISTICS

$E_f = 6.3$ VOLTS

PLATE VOLTS = 250

SCREEN VOLTS ($E_{C2}$ & $E_{C4}$) = 100

--- = A.V.C. CHARACTERISTIC

FIG. 1

SIGNAL-GRID VOLTS ($E_{C1}$)

SIGNAL-GRID-TO-PLATE ($G_{1}$ TO $P$) TRANSCONDUCTANCE

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