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APPLICATION NOTE
ON
THE 6L7 AS A VOLUME EXPANDER FOR PHONOGRAHS

The ratio of maximum to minimum amplitudes that is feasible to re-
cord phonographically is not sufficient to take care of very large volume
changes, such as may be produced by a symphony orchestra. For this rea-
son, very large ranges in sound intensity are reduced in some way before
the record is made. Such reduction, known as "compression," is usually
accomplished manually by careful monitoring.

Most home phonographs have no provision for expanding the signal
in order to compensate for the compression introduced at the time of re-
cording. Hence, passages are distorted in the sense that they are not re-
produced with full volume range. If full compensation for compression is
desired, it is necessary to provide the phonograph with some means for
increasing the amplification of loud passages in the same proportion that
they were compressed at the recorder. However, if the volume control on
the phonograph is set for reasonably loud volume on expanded passages,
the residual noise level in the room may impair reception of soft passages
when full expansion is used. Therefore, full compensation may not be
desirable.

The characteristics of the type 6L7 tube permit its use in a com-
paratively simple volume-expander circuit. This tube has a heater, a cath-
ode, five grids, and a plate. Two of the five grids are control grids;
the first (G₁) has a remote cut-off characteristic and the second (G₃) has
a sharp cut-off characteristic. Of the three remaining grids, two are
screws and one is a suppressor.

The schematic diagram of a volume expander is appended. The signal
to be expanded is fed to the remote cut-off grid (G₁) of a 6L7 and also
to the input of a 6C5, as shown. The output of the 6C5 is rectified by a
6H6; the positive terminal of the rectified output connects to the sharp
cut-off grid (G₃) of the 6L7. The no-signal bias of this grid is such that
the G₁-Plate transconductance of the 6L7 is low (under 50 microhmhos). When
a signal is applied, the rectified voltage fed to G₃ increases the trans-

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conductance, and hence the gain, of the 6L7. This increase in gain is approximately proportional to the rectified diode voltage and, hence, to the signal amplitude.

It is essential that the time constant of the circuit generating the control voltage be so adjusted that changes in this voltage occur only for comparatively slow changes in signal amplitude. If the time constant is too short, speech will sound particularly unnatural; if the time constant is too long, there will be an objectionable lag. A time constant of 0.25 to 0.5 second is generally regarded as a satisfactory choice.

Distortion of the signal due to the characteristic of the remote cutoff grid (G1) is appreciable for large signals. Therefore, the maximum signal input to G1 should be 1 volt peak, which is of the same order as that obtainable from the usual magnetic phonograph pick-up.

The plate-current value of the 6L7 serves as a good measure of the degree of expansion. It is suggested, therefore, that the initial bias on G3 be adjusted for a no-signal plate current of approximately 0.15 milliampere by means of potentiometer P. This potentiometer requires no further adjustment if the same 6L7 is always used. The plate of the 6H6 may be biased negatively in order to delay expansion until a predetermined signal amplitude is reached. This delay voltage may be inserted at point X.

Although this system can operate from a radio receiver to provide expansion, it is suggested that, at the present time, volume expansion be used for phonograph reproduction only. Since large unanticipated changes in sound level during a broadcast may not be adequately monitored, the expander will act to exaggerate these changes. It is not probable that such accidental changes will be present in a phonograph record.
VOLUME-EXPANDER CIRCUIT USING 6L7 TUBE

NOTE: ALL TERMINAL POINTS ON POWER UNIT SHOULD BE ADEQUATELY BY-PASSED.