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

APPLICATION NOTE No.112
April 8, 1941

USE OF THE RCA-6SF7

The 6SF7 is a new single-ended metal tube containing a remote cut-off r-f pentode and a diode in the same envelope. Its grid-plate capacitance and its grid-diode capacitance have been kept low, partly by utilizing a suitable arrangement of terminal leads, and partly by the shielding action of the metal shell. Characteristic curves are included at the end of this Note.

For receivers utilizing single-ended metal tubes, the 6SF7 is particularly useful as an i-f amplifier and detector. In this use, the pentode plate of the 6SF7 is coupled to the diode plate through a tuned transformer; the a-f output circuit of the diode detector is conventional.

This arrangement has the important advantage, among others, of eliminating the familiar problem of "play-through," a condition encountered when the diode detector and the first a-f amplifier are in the same envelope and have a common cathode. "Play-through" ordinarily results from capacitive or electronic coupling between the diode plate and the first a-f amplifier. It occurs, regardless of the volume-control setting, because the internal coupling may transfer either the i-f voltage or the a-f voltage present at the plate of the diode to the a-f circuit. If the a-f system can feed back to the r-f or i-f circuits, the presence of i-f currents in the a-f system may result in other spurious effects such as regeneration or oscillation, and may produce "birdies" when the r-f signal frequency is a multiple of the intermediate frequency. When the 6SF7 is used as the i-f amplifier and the detector, the fundamental cause of such spurious effects is eliminated because i-f voltage can not reach the a-f tube and because the a-f voltage delivered to the a-f tube can be only that delivered by the volume control. The elimination of "play-through" effects also makes it possible to use the a-f system for phonograph reproduction or similar services without the necessity of making the r-f system inoperative by detuning it or by removing voltages from it.

When the 6SF7 is used as the i-f amplifier and diode detector, a desirable tube complement for a receiver with push-pull, power-output stage could be: a 5Y3-G rectifier, a 6SA7 converter, a 6SF7 i-f amplifier and diode detector, a 6SC7 phase inverter, and a push-pull 6K6-GT power amplifier.

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Another use of the 6SF7 as the i-f amplifier and the diode detector is found in receivers employing a degenerative audio-output stage. In these, a separate first a-f tube can be used which may be either a 6SJ7 or a 6SK7. This arrangement permits the use of a desirable method of inverse feed-back, known as the "constant-voltage type." It is accomplished by connecting a suitable resistor from the plate of the output stage to the plate of the first a-f stage. The success of this method is much enhanced when the first a-f stage utilizes a pentode having high plate impedance, instead of a triode with its relatively low plate impedance, because the plate impedance shunts the plate load. A low effective value of plate load leads to difficulties in obtaining an adequate degree of feed-back.

The 6SF7 has optional use as a resistance-coupled a-f amplifier. In this service, its remote-cut-off characteristic makes it suitable for audio automatic-volume-control. Receiver tests have shown that this use of the 6SF7 need not materially increase the over-all distortion.

Some Effects of Tube Capacitance

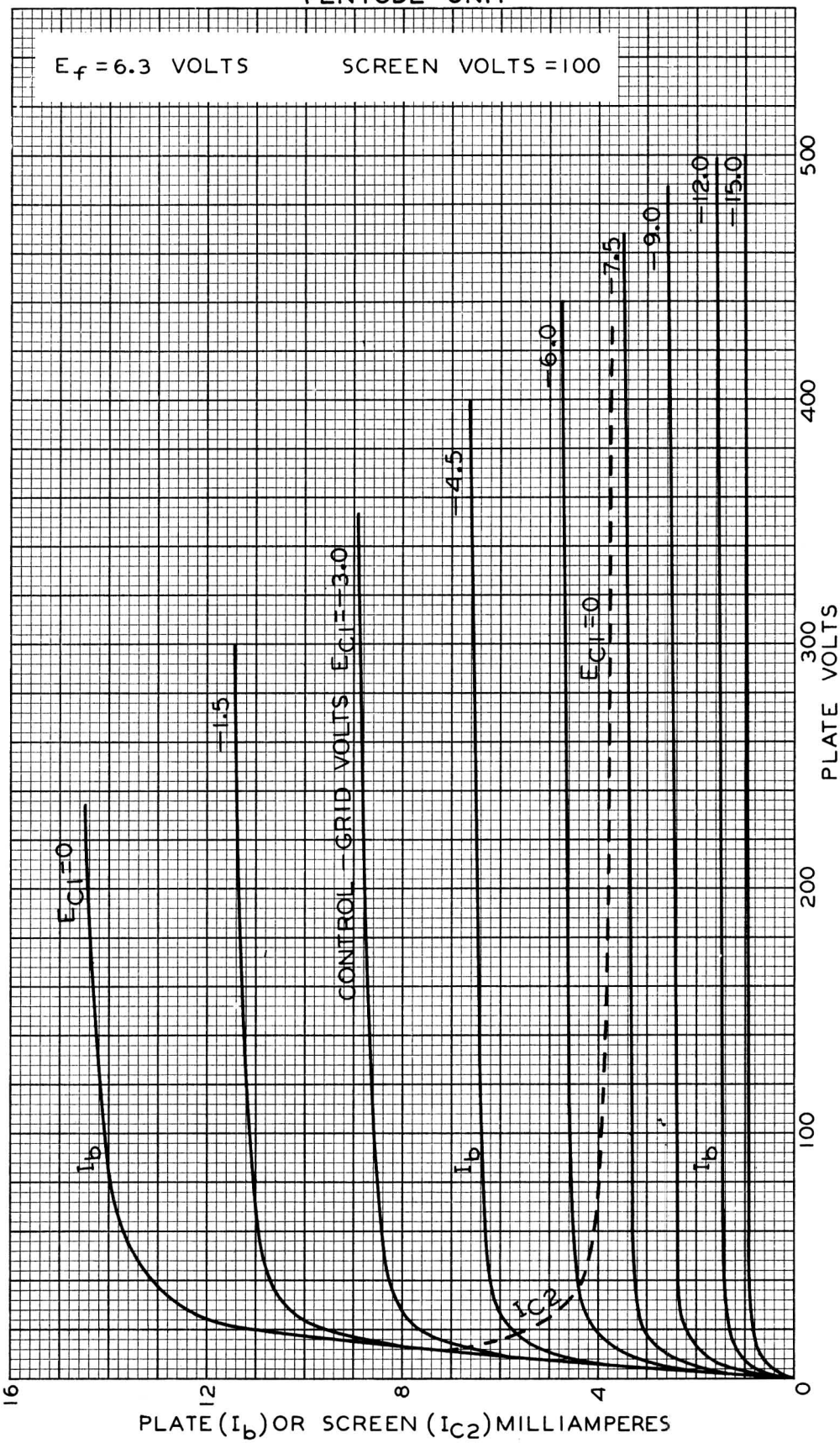
When the diode is in the same envelope with the i-f amplifier, the effects of capacitance between diode and plate, and between diode and control grid, must be taken into account in circuit design. The diode-to-plate capacitance of the 6SF7 is approximately 0.8 $\mu\mu$f. This capacitance adds to the capacitance normally present between the primary and secondary windings of the i-f transformer, and must, therefore, be considered in determining the proper amount of magnetic coupling. The diode-to-grid capacitance of the 6SF7 is very low -- 0.002 $\mu\mu$f max. -- but the capacitances between socket terminals and leads must be taken into account. The feed-back which results from capacitance between diode and grid manifests itself in a manner somewhat different from that which results from plate-to-grid capacitance; the effect is either an increase or a decrease in gain, with either sharpening or broadening of the i-f resonance curve, and with the maintenance of symmetry in the shape of the i-f curve. When both circuits of an i-f transformer are tuned to resonance at the intermediate frequency, the voltage across the secondary is 90° out of phase with the voltage across the primary; the current through the capacitance between the secondary and the grid (i.e., the diode-grid capacitance) is 90° out of phase with the secondary voltage. This current is either in phase or 180° out of phase with the voltage at the grid. The result is that the maximum feed-back effect -- regenerative or degenerative -- occurs when the circuits are tuned to resonance at the intermediate frequency; the effect decreases symmetrically when the frequency is increased or decreased from the resonance value. The current through the capacitance between the primary and the grid (i.e., the pentode plate-grid capacitance) is 90° out of phase with the grid voltage when the plate circuit is tuned to resonance at the intermediate frequency. The feed-back from this source is regenerative when the frequency is lower than the resonance value, and degenerative when the frequency is higher. These effects account for the unsymmetrical resonance curves obtained when grid-to-plate capacitance is the predominant cause of feed-back.

These considerations indicate that capacitance between diode and grid is less objectionable than capacitance between plate and grid. Consequently, in the 6SF7, the plate is brought out to the base terminal connection opposite the grid terminal.

6SF7

AVERAGE PLATE CHARACTERISTICS

PENTODE UNIT



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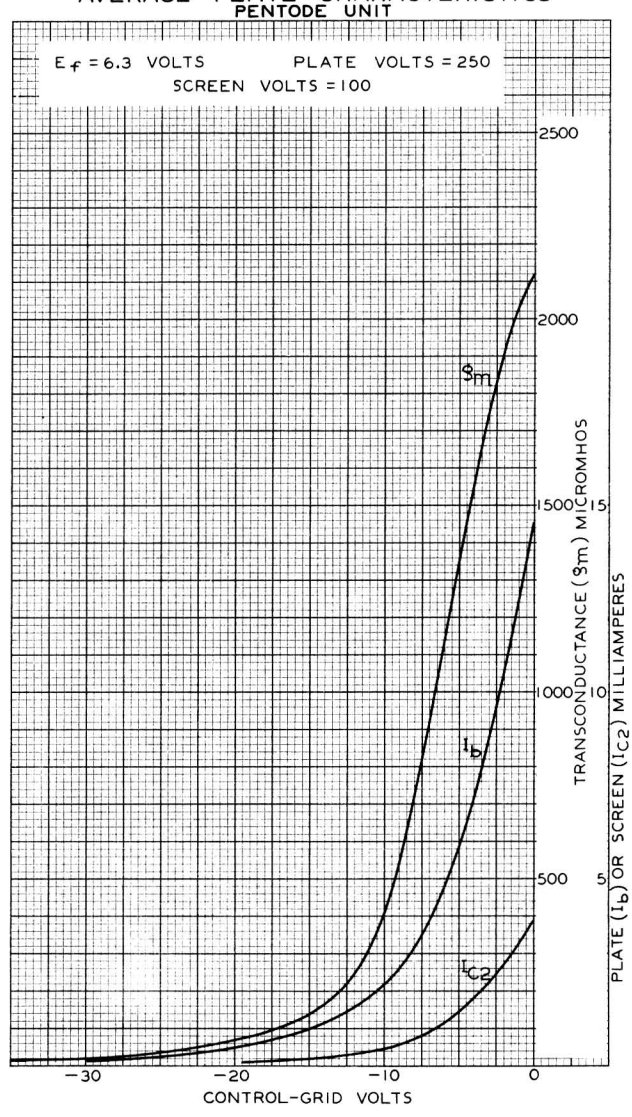
6SF7

AVERAGE PLATE CHARACTERISTICS

PENTODE UNIT



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