



## RCA MANUFACTURING COMPANY, INC.

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**RCA RADIOTRON**  
D I V I S I O N

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### APPLICATION NOTE ON RECEIVER DESIGN

This Note discusses several topics that relate to radio-receiver design. In addition to information on the characteristics of tubes and circuits, suggestions for improving receiver performance are offered. The information in this Note is based on our experience with receivers in production and in the process of design.

#### Battery-Operated Receivers

Many battery-operated receivers employ a dual off-on switch in order to control filament and B-supply voltages simultaneously. Such receivers may block when this dual switch is opened and closed rapidly. The reason for the blocking can be seen from the a-f portion of a receiver circuit, shown in Fig. 1.

When the ganged switches ( $S_1$  and  $S_2$ ) have been closed for some time, the temperature of the filament is normal and the circuit is in operating condition. When  $S_1$  and  $S_2$  are opened, the temperature of the filament decreases and condenser C discharges almost immediately. Now, when  $S_1$  and  $S_2$  are closed before the temperature of the filament reaches a very low value, the charging current from the B-battery through circuit  $R_1$ , C,  $R_2$  causes the grid of the tube to become positive by an amount equal to the voltage drop across  $R_2$ , and the temperature of the filament starts to increase. Thus, due to the heating lag of the filament, it is possible for the grid to be highly positive while the temperature of the filament is less than normal. The grid may emit secondary electrons under such conditions. This secondary-emission current flows in the same direction as the charging current ( $i$ ); thus, the positive potential of the grid increases to a high value. The transconductance and, hence, the output of the tube is low under these conditions. Normal operation can be restored by turning the receiver off long enough for the filament to cool to a low temperature and then turning it on again.

Two methods may be used to eliminate this undesirable blocking. The lead to  $R_1$  may be broken at x, Fig. 1, and  $R_1$  connected directly to B+, as shown by the dashed line. With this connection, the B-battery is connected to T, through  $R_1$  at all times; hence, no charging current flows through C when  $S_2$  is closed.

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A second method of eliminating the trouble is to delay the closing of  $S_2$  until the temperature of the filament is high enough to avoid secondary emission from the grid.

This secondary-emission effect is not peculiar to the output stage or to a particular tube type, it may occur in any resistance-coupled-amplifier stage

### Output Transformer

Measurements on a number of output transformers designed for a-c/d-c receivers indicate that an appreciable improvement in performance may be obtained by increasing the length of the air gap. The improvement obtained in one case is shown by the curves of Fig 2. The proper load for the transformer was connected to the secondary, the total impedance across the primary terminals was measured at 420 cycles for different values of direct current through the primary with normal field current. The total impedance should have been approximately 2000 ohms for a direct current of 50 milliamperes through the primary, the measured value was found to be 1560 ohms.

The variation in impedance with current is more important than the absolute value of the impedance. When the load impedance of a single-tube amplifier varies with current, the output is distorted, this distortion cannot be minimized by an adjustment of the bias or of the load impedance

The impedance characteristic shown by curve A of Fig 2 was corrected to that of curve B by an increase of 0.003 inch in the length of the air gap. A few turns were removed from the secondary in order to raise the impedance to a higher value. The important result, however, is the reduced change in impedance with current, because distortion is introduced by a load impedance which varies throughout the signal cycle

### Converter Tubes

Difficulty is often experienced in lining up the oscillator and signal circuits of a pentagrid converter due to coupling between oscillator and signal sections of the tube. This difficulty is most noticeable at the high-frequency end of the high-frequency band. It has been found that a resistor of approximately 50 ohms connected in series with the signal grid (No 4) and the tuned circuit reduces lining-up difficulties

### Separate AVC Diode Circuit

When separate diodes are used for detection and avc, and the i-f transformer is connected through a condenser to the diode, it is desirable to employ a condenser of 50 to 100  $\mu\mu\text{f}$ . Values of coupling condensers greater than 100  $\mu\mu\text{f}$  cause an appreciable decrease in output voltage at the higher audio frequencies.

The avc diode loads the i-f transformer to which it connects (Fig 3). Increasing the value of the coupling condenser increases the loading, for a given value of coupling condenser, the loading increases with modulation frequency. A 50 to 100  $\mu\mu\text{f}$  coupling condenser is suitable for most purposes. In one instance, a decrease in the value of this condenser from 250  $\mu\mu\text{f}$  to

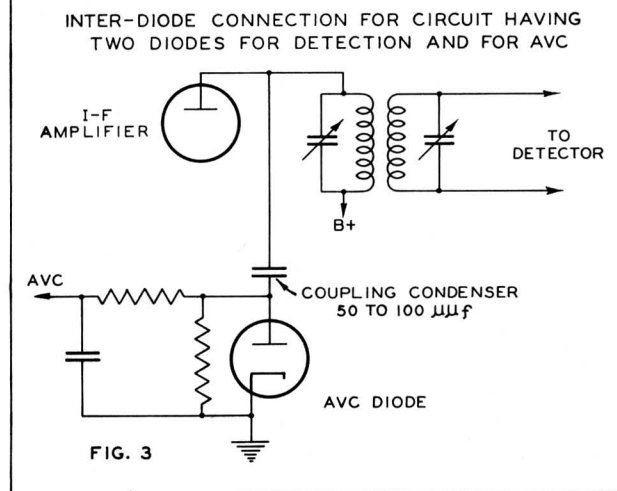
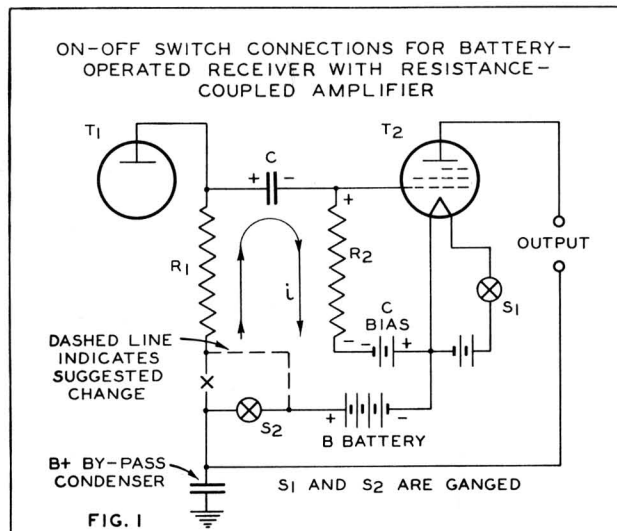
50  $\mu\text{f}$  doubled the voltage output at 5000 cycles. This change in output does not include the attenuation at 5000 cycles due to the selectivity of the i-f transformer.

### Oscillation

Difficulties due to oscillation in the output stage may be experienced when the transconductance of the output tube is high. In the case of the 25L6, 6L6, 6L6G, or 6V6G, it may be necessary to shunt the bias resistor with a small mica condenser (approximately 0.001  $\mu\text{f}$ ) in order to prevent oscillation, the usual electrolytic by-pass condenser is also used across the bias resistor when degeneration is not desired.

Another aid in suppressing oscillation is to ground the shell of each all-metal tube with a short, heavy wire. When the impedance in series with the shell is appreciable, spurious oscillations at high frequencies may occur. This type of oscillation may be detected by an oscillograph or by measuring the screen current, the screen current will be appreciably higher than normal when the tube oscillates.

The following suggestions have been effective in suppressing oscillation in push-pull output stages using glass-type tubes. (1) Connect a 500-ohm resistor in series with the control grid of each output tube, each resistor should be mounted as close as possible to the grid terminal of the socket to which it connects. (2) Mount each plate by-pass condenser as close as possible to the plate terminal of the socket to which it connects. The purpose of the suppressor resistor and the plate by-pass condenser may not be served when they connect to a tube through comparatively long leads.



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OUTPUT TRANSFORMER CHARACTERISTICS

