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DELUXE RECEIVER GAIN CONTROL

It is well-known that for obtaining optimum gain and noise figure, the front-end of a tube-type high-frequency communications receiver should emloy a high-transconductance sharp-cutoff pentode run at maximum gain without agc. However, most commercial receivers use a variable-μ pentode for the convenience of easy gain control.

When I pulled out the 6SG7 amplifier in my receiver and directly substituted a 6SH7 sharp-cutoff pentode, the improvement in the sensitivity and noise figure of the receiver was truly remarkable. The plate voltage was 250V and the screen voltage 100V. A cathode bias resistor of 100Ω was provided and agc was disconnected from the first stage.

This improvement in performance, however, is accompanied by a drawback. With strong signals, there is overloading of the mixer, resulting in distortion and audio splashing. This can be eliminated by inserting a separate gain control in the form of a potentiometer in the cathode line of the rf amplifier. Although the range over which the gain of a sharp-cutoff pentode can be varied without curtailing its signal-handling ability is limited, sufficient variation in gain does occur to prevent overloading of the mixer with strong signals.

When using a sharp-cutoff pentode in the front end, the ideal way of controlling the receiver gain is therefore to run the rf amplifier at full gain on all but very strong signals, and reduce the gain just to the extent necessary on strong signals. Figure 1 shows a circuit in which the rf gain of the front end is electronically locked to the i-f gain and tracks with it in the desired manner. The circuit needs just one transistor, a zener, three resistors, and a bypass capacitor. The values of the three resistors shown in the figure should be taken only as a rough guide; for every receiver, the proper values of the resistors are to be determined experimentally, as explained below.

To start with, a 10 kΩ potentiometer is temporarily used as a separate rf gain control. A very strong signal is tuned in and the gain control is backed up until all traces of front-end overloading disappear. The resistance of the potentiometer then gives R1. The corresponding cathode bias will be of the order of 4–6V.

R2 determines the cathode bias at full gain. Its value depends on the tube and transistor characteristics and should be determined experimentally so that the cathode bias at full gain is the recommended value for the tube (–1.0V for 6AU6 and 6SH7; –2.0 volts for 6AH6 and 6AC7).

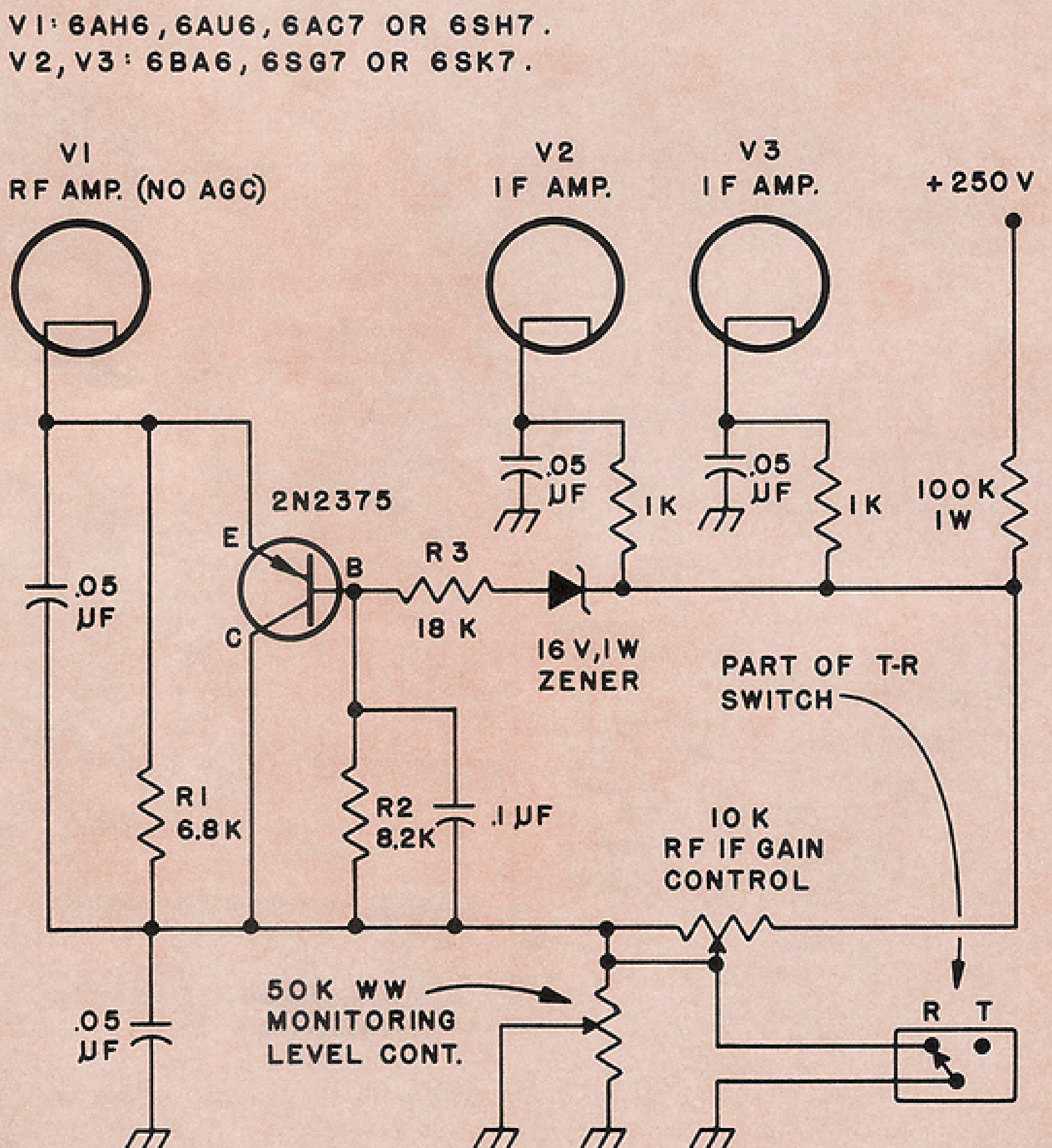

Fig. 1. In this circuit the front-end gain is "locked" onto the i-f gain and tracks with it.

The zener determines the bias voltage at which the rf gain begins to track with the i-f gain. Zeners in the voltage range of 16–22V will be in order. I did not encounter any noise or avalanche problem in using the zener. As the bias voltage of the i-f stages rises, the zener current increases the base voltage of the transistor and lowers its conduction, thus raising the cathode bias of the rf amplifier.

R3 governs the tracking of the rf gain with the i-f gain. Its value should be such that with the gain control at minimum, the cathode bias of the rf amplifier just approaches the maximum usable bias determined at the outset.

The transistor used should be a low-leakage high-gain PNP germanium transistor. The 2N2375 which I used showed an I_{ceo} of less than 100 μA and a beta of 100 under normal test conditions. Since the transistor has practically negligible collector dissipation, it is able to survive in the very unfavorable surroundings inside the receiver chassis!

In the transmit position, the 50 kΩ monitoring level control comes in series with the rf gain control. This overbiases the i-f stages while the rf amplifier, in view of its sharp-cutoff characteristic, gets completely cut off. This permits comfortable monitoring of the transmitted signal.

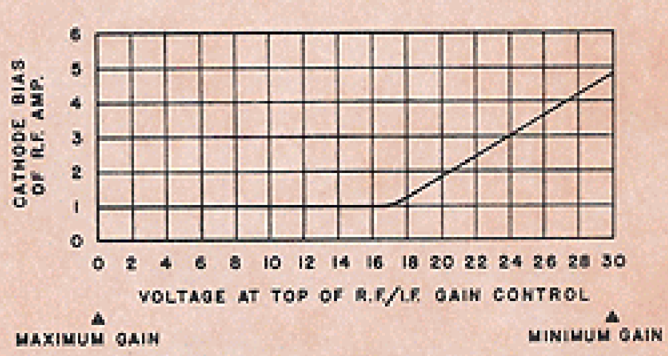

Fig. 2. Tracking curve shows smooth voltage transition with increased voltage bias.

Figure 2 shows the observed smooth tracking of the rf stage bias with the i-f stage bias. Flattening of the right end of the curve due to the transistor getting cut off can be avoided by increasing the value of R3. The performance of this gain control leaves little to be desired.

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