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LB-815

A CENTER-TUNING CIRCUIT FOR FM DETECTORS

RADIO CORPORATION OF AMERICA

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Approved

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Introduction

When tuning an FM receiver or a conventional dual i-f channel television receiver, there is the problem of tuning to the center response rather than to either of the two incorrect side responses which bracket it. Because these undesired responses may sound almost as strong as the desired center response, tuning is confusing to some users. In this bulletin a relatively simple circuit is described which eliminates these undesired responses on all but weak signals, and even for them the tuning characteristic is improved.

The basic circuit is suitable for both dual-channel television receivers and FM receivers, and can be used with FM detectors of the discriminator or ratio detector types. Most of the test results were obtained on an RCA 8T244 television receiver.

Since attenuation of the side responses is obtained at the expense of a narrowing of the center response, a compromise must be made so that tuning does not become excessively sharp or too vulnerable to oscillator drift.

Principle of Operation

The circuit operates on the bias of the first audio amplifier tube to provide full audio gain only when the receiver is properly tuned. The voltages for doing this are derived from the d-c output of a balanced FM detector, the additional circuitry consisting of resistors, a capacitor, and two diodes which may have a common grounded cathode.

Circuit Description

One arrangement of the circuit is such that a negative bias is applied to the grid of the first audio tube except when there is a signal producing nearly balanced output from the discriminator. Such an arrangement is shown in Fig. 1, which shows in light weight lines the pertinent portions of a standard discriminator circuit as used in an RCA 8T244 television receiver, and in heavy lines the new circuitry. The audio output at point A is substantially

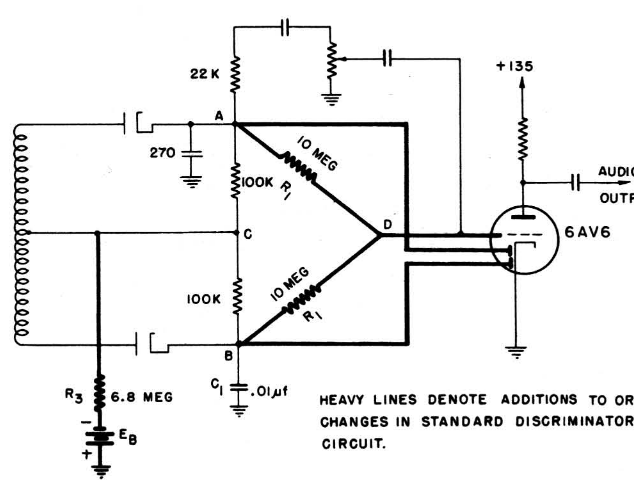

Fig. 1 - Center tuning circuit as applied to an RCA 8T244 receiver.

the same as for a standard discriminator, for although the normal d-c connection to ground at point B has been removed, point B is by-passed for audio frequencies and all other circuit additions are high resistances having practically no a-c loading effect on the discriminator output. The d-c voltages, however, operate in an unconventional manner. When the receiver is completely mistuned, no rectified voltage is developed at points A and B compared to point C and they are all negative with respect to ground by the potential E_B. Point D and the two diode anodes of the 6AV6 are also held negative by this amount. As the receiver is tuned toward the center of the discriminator, both of the discriminator diodes will begin conducting, one more than the other. If, for example, the upper diode conducts more than the lower diode, point A will become more positive with respect to point C than will point B: therefore point B will be negative with respect to point A. As tuning toward the center frequency continues, a frequency will be reached where the positive potential from A to C equals the negative bias E_B, making zero the net potential at point A with respect to ground. At this frequency the upper diode in the 6AV6 begins conducting and prevents further increase in the potential at point A. Additional rectified voltage developed between points A and C then results in depression of the voltage at C to a value more negative than E_B. All the while the voltage at point D has been one-half of the sum of the voltages at points A and B. Since point A was always negative or zero, and point B always negative, point D was also always negative. When the center tuning region of the discriminator is reached the rectified voltage from B to C will be equal to that from A to C, A and B will be at the same potential, and both will be zero since both 6AV6 diodes will then begin to conduct. In this region the potential at point D will approach zero and the triode section of the 6AV6 will operate to amplify the audio signal in a normal fashion. As the receiver is tuned in from the opposite side of center frequency the results are the same as just described, except that the potential at A and B reverse. For good cutoff except when tuned to the center frequency a high-mu triode operated from a low or medium plate supply voltage is required. Also because of the high resistances in the d-c circuit, the diodes which keep points A and B from going positive should be of the vacuum tube typ rather than crystal diodes. The discriminato diodes could be crystals if desired, however.

Source of Bias Voltage E_B

In Fig. 2 the negative bias corresponding to E_B is obtained from the a-g-c voltage of the receiver. This has the advantage of providing sufficient bias to eliminate completely si responses on most stations, yet will provide

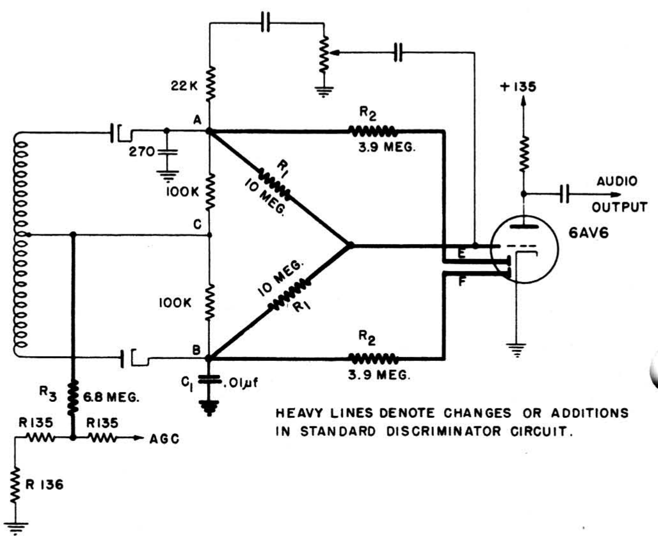

Fig. 2 - Center tuning circuit as applied to an RCA 8T244 receiver.

reduced bias for the very weak ones so that their sound will not be cut off when properly tuned. It should be pointed out that even when the a-g-c voltage is zero the operation of the circuit still improved the ratio of the strength of the center audio response to the undesired side responses by an amount depending upon the signal strength in the sound channel.

Broadening the Center Response

The resistors R_2 have also been added in Fig. 2. Their purpose is to broaden the region of full audio response near the center tuning point, if that should be desired, which purpos they accomplish by allowing point A or point B whichever tends to be most positive, to become positive with respect to ground by an amount depending upon the a-g-c voltage and the ratio of R_2 and R_3. The bias at point D then remains near zero for a greater tuning range near the center, but does not actually go positive due to development of self bias by the grid of the 6AV6. If the ratio of R_2 to R_3 is increased the center response region becomes broader and the side response rejection poorer.

Results Compared to Standard Discriminator Circuit

Fig. 3 illustrates a comparison test made between the new circuit of Fig. 1 and the standard circuit. It can be seen that the side responses are reduced about 20 times by the new circuit.

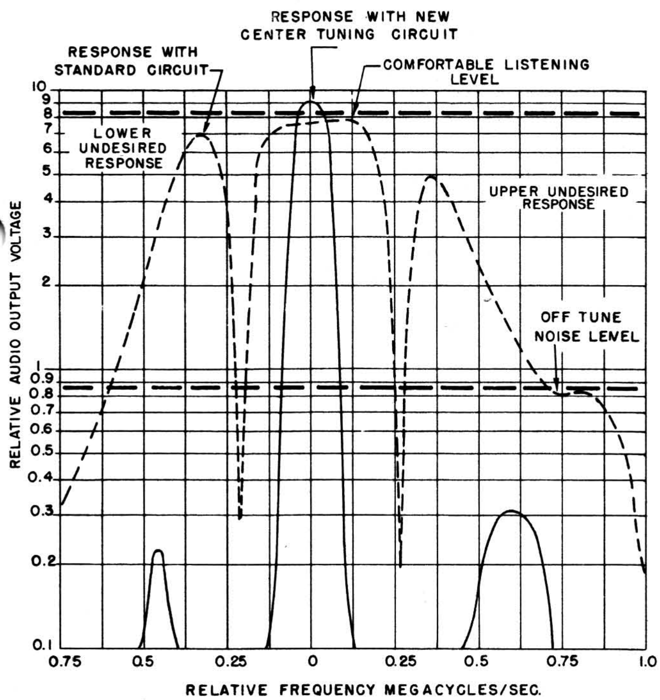

Fig. 3 - Comparison between new and standard circuits.

Ratio Detector Version

Fig. 4 shows the adaption of the center tuning circuit to a standard type ratio detector. The operation of this circuit is similar to that with the standard discriminator. However, in this case, the d-c voltages are developed at the center of the diode resistors and at the i-f end of the diodes. From the theory of operation of the ratio detector, it can be seen that a

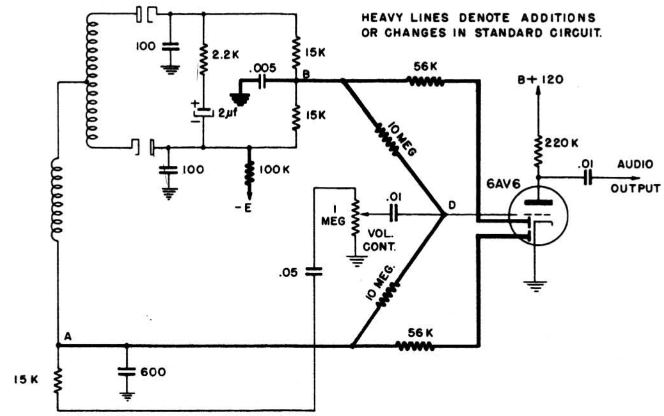

Fig. 4 - Center tuning circuit as applied to a standard type ratio detector circuit.

d-c potential will exist between points A and B of Fig. 3, except when the receiver is far off tune or correctly tuned. As the receiver is tuned toward the center frequency, this voltage rises to a maximum and then decreases to zero at the center. Since neither point A or B can go positive with respect to ground because of the clamping diodes, on either side of the center frequency one point will be held and the other will go negative. Thus a negative voltage with respect to ground is developed at point A or B either side of the center frequency. As in the case of the back-to-back discriminator, part of this negative voltage is used to bias off the audio tube except at the center frequency.

An initial negative bias can be supplied at point C through the 100 K resistor. This will eliminate interstation noise and further reduce the amplitude of the side responses. This initial bias can be supplied in an FM receiver from several different sources - for example, the set a-g-c voltage, the oscillator grid bias voltage, or cathode bias on the audio tube supplied by a B+ bleeder resistor and a small cathode resistor. If a fixed bias is used, there will be a threshold value at which the weaker stations will develop just enough diode current to turn on the audio tube, thus a tap switch or other threshold control may be desirable to enable complete elimination of side responses in strong signal areas, or set to allow reception of signals in a weak signal area. This would correspond to the a-g-c threshold control in a television set.

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