From ARRL Handbook, year unknown

Image Rejection in the D-C Receiver

Rejection of noise and signals on one side of the LO is a major enhancement and also a major complication of the D-C receiver (Refs 11, 12). **Fig 17.17** shows two correct ways to build an image canceling mixer and one incorrect way. The third way does not perform the required phase cancellations for image reduction. In practice, two ±45° phase shifters are used, rather than one 90° stage. As mentioned before, it is very difficult to get close phase tracking over a wide band of signal and LO frequencies. In amateur equipment, front panel "tweaker" controls would be practical.

The block diagram in **Fig 17.18** is a typical approach to an image-canceling D-C receiver. The two channels, including RF, mixers and audio must be very closely matched in amplitude and phase. The audio phase-shift networks must have equal gain and very close to a 90° phase difference. **Fig 17.19** relates phase error in degrees and amplitude error in dB to the rejection in dB of the opposite (image) sideband. For 30 or 40 dB of rejection, the need for close matching is apparent.

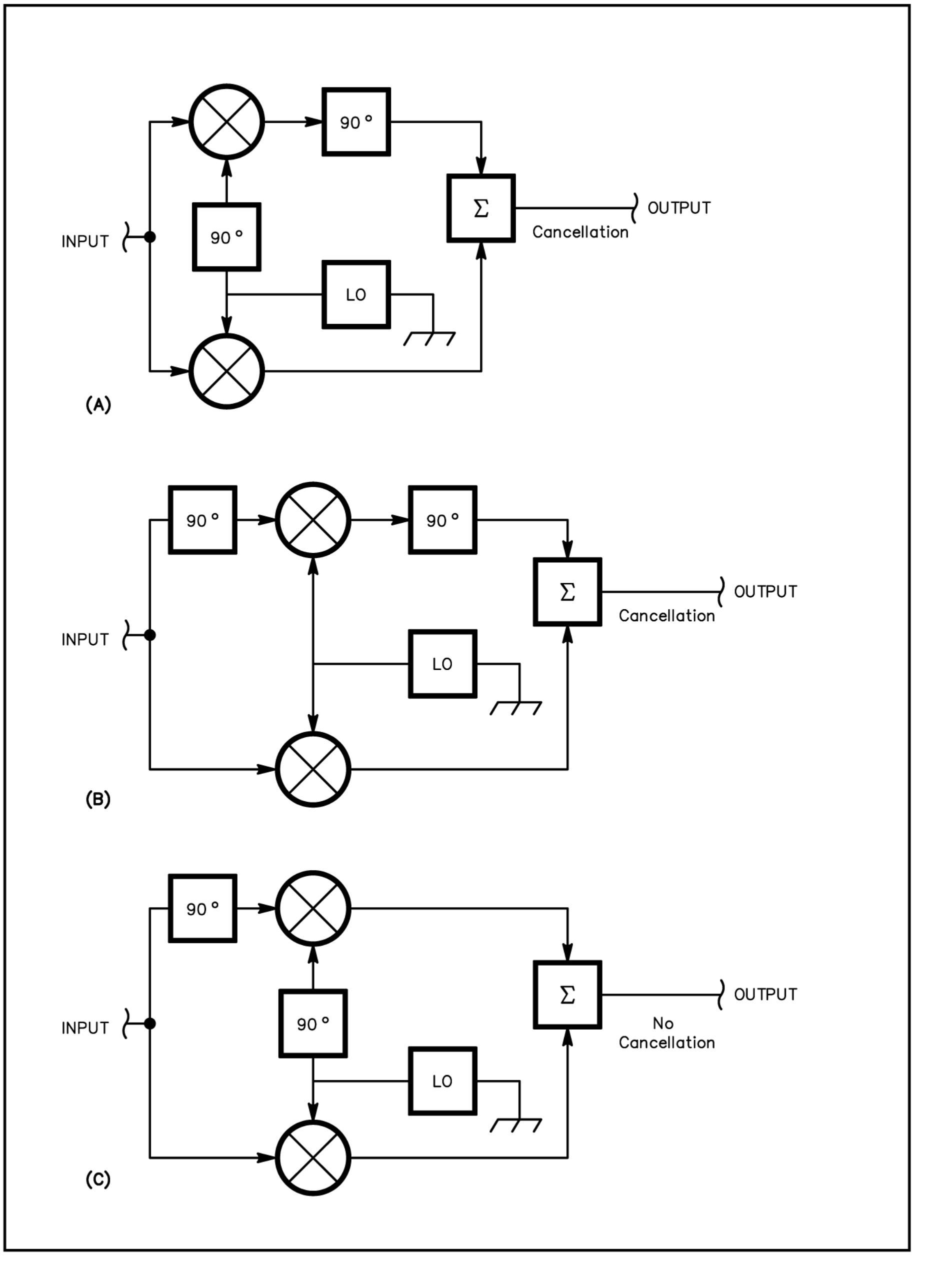

Fig 17.17—Both A and B are workable image cancelling mixer stages. The scheme at C will not cancel image signals.

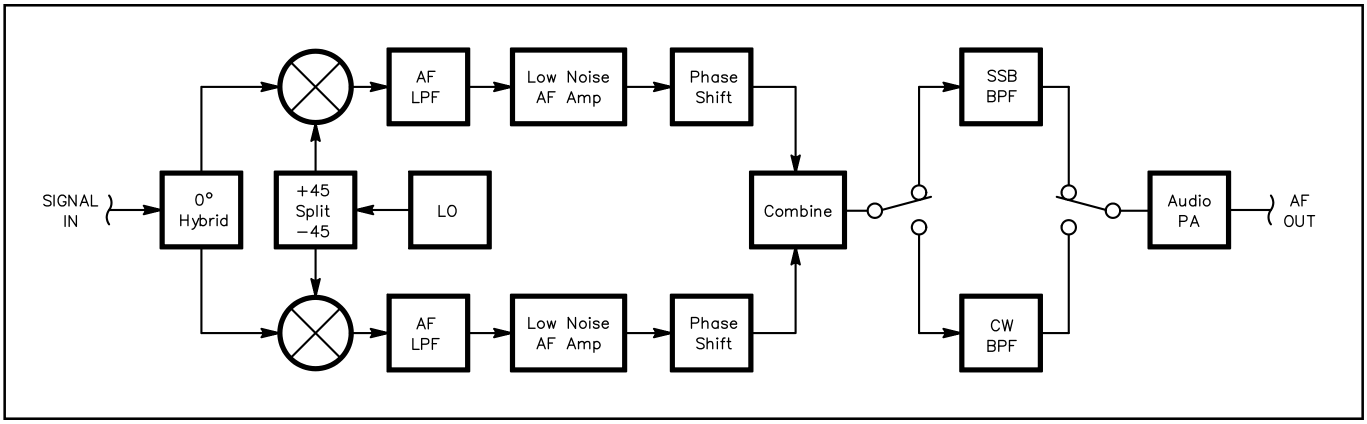

Fig 17.18—Typical block diagram of an image cancelling D-C receiver.

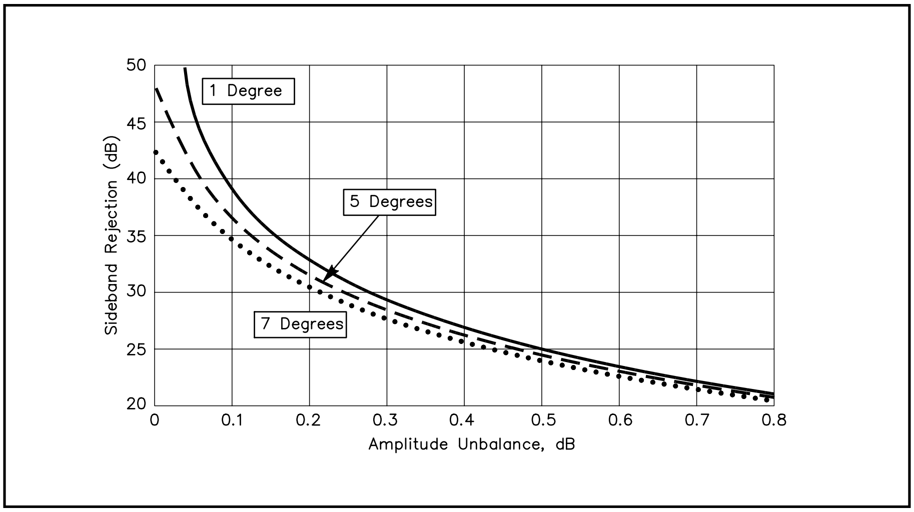

Fig 17.19—A plot of sideband rejection versus phase error and amplitude unbalance.

AUDIO PHASE SHIFTERS

Fig 17.20A shows an example of an audio phase-shift network. The stage in Fig 17.20B is one section, an active "all-pass" network that has these properties:

- The gain is exactly 1.0 at all frequencies and
- The phase shift changes from 180° at very low frequency to 0° at very high frequency.

The shift of this single stage is +90° at $f = 1/(2pRC)$. By cascading several of these with carefully selected values of RC the set of stages has a smooth phase shift across the audio band. A second set of stages is chosen such that the phase difference between the two sets is very close to 90°. The choices of R and C values have been worked out using computer methods; you can also find them in other handbooks (Ref 13). Fig 17.20C shows the phase error for two circuits like the one shown in Fig 17.20A. Note the rapid increase in error at very low audio frequencies (an improvement would be desirable for CW work). These frequencies should be greatly attenuated by the audio band-pass filters that follow.

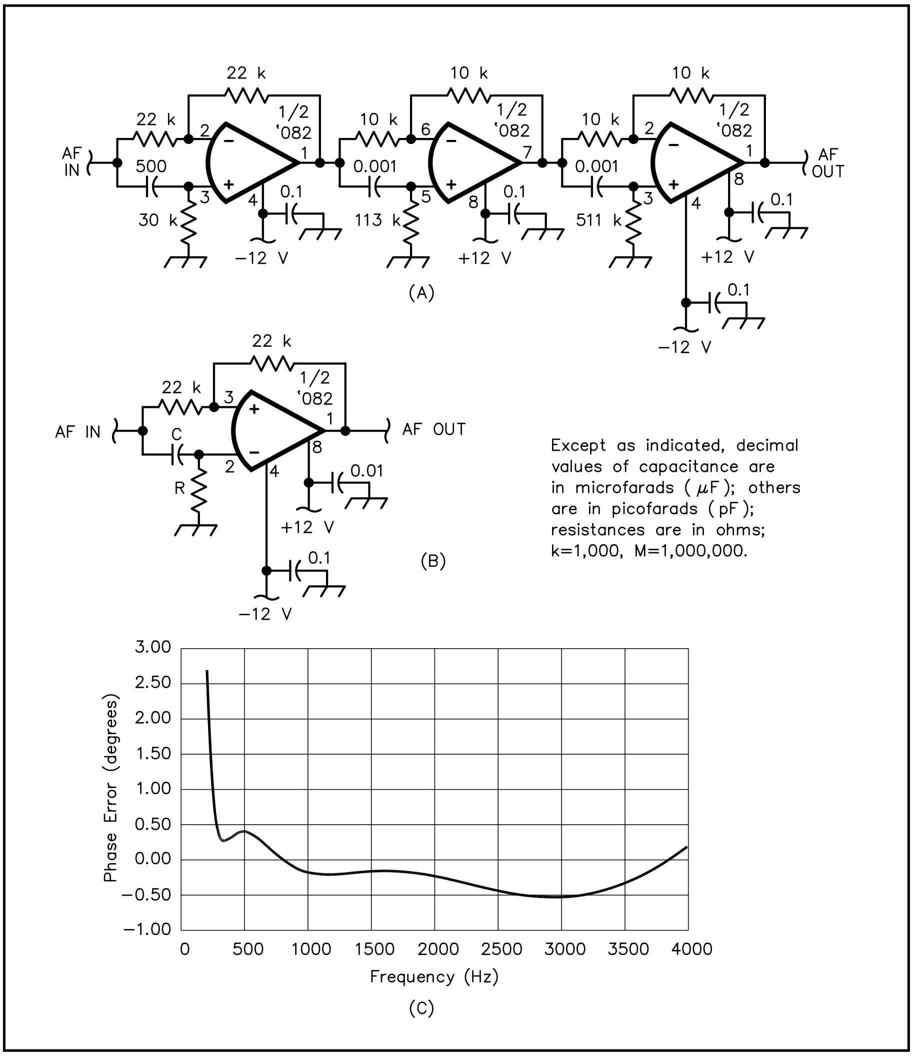

Fig 17.20—A: an example of an audio phase-shift circuit. B: a single all-pass stage. C: phase error vs audio frequency for a pair of circuits like that in A with appropriate values of R and C.

D-C Receiver Problem Areas

Because of the high audio gain, microphonic reactions due to vibration of low-level audio stages are common. Good, solid construction is necessary. Another problem involves leakage of the LO into the RF signal path by conduction and/or radiation. The random fluctuations in phase of the leakage signal interact with the LO to produce some unpleasant modulation and microphonic effects. Hum in the audio can be caused by interactions between the LO and the power supply; good bypassing and lead filtering of the power supply are needed. A small amount of RF amplification is beneficial for all of these problems.