RSGB EMC COMMITTEE WEB SITE REFERENCE SECTION

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Part of Chapter 7 of RSGB Guide to EMC

Text taken from the draft copy of *The RSGB Guide to EMC* which is now out of print. It will differ from the published version in format and in minor changes and corrections. It has not been updated but may include minor editorial changes to accommodate stand-alone presentation.

Figures retain the numbers of the original copy.

INTERFERENCE CANCELLING

Interference cancelling

Cancelling is not so well known as limiting or blanking, which is surprising since it is a very powerful technique. It has two big advantages: first, it will work with any type of interference and, second, it does not require any modification to the receiver (or transceiver) itself. For amateur operation, interference cancelling is more common on the HF bands, though the same technique can be used at VHF.

The canceller works by utilising the difference in phase between the wanted signal and the interference. If two receiving antennas are set up some distance apart and the same signal is received on both, then the phase relationship between the currents in the two antennas will depend on the direction from which the signal comes (Fig 7.17(a)). If the two outputs from the antennas are adjusted to be exactly the same in amplitude and exactly 180° out of phase, then if they are added together, they will cancel leaving almost no residual signal. The key to a practical canceller lies in the word ŕexactlyô; if the phase and amplitudes are not just right, most of the cancelling effect is lost. This is very similar to the loop antenna, or the far more familiar ferrite rod antenna, widely used for direction finding. The null is very sharp, but away from the null the signal strength does not change much (Fig 7.17(b). In practical amateur reception it is most unusual for two independent signals to have exactly the same null, even if they come from more or less the same direction ï on HF most wanted signals arrive at the receiving antenna by a sky-wave path, while the majority of local interference comes along the ground.

In an interference canceller the gain and phase of the signals in the two antennas are adjusted, using two control knobs, until the interference is nulled out, leaving the wanted signal more or less unaffected. How much the wanted signal will be affected depends on the relative directions from which the two signals are coming and the distance between the two antennas. As a rule of thumb, for interference coming from a fairly long way off (several wavelengths away), the antenna spacing should not be much less than one quarter-wave at the frequency of operation, though much smaller spacing can be used if some degradation of reception is acceptable. Where the interference source is much closer, the situation becomes very complicated, and it is simpler not to think in terms of antennas and nulls, but of picking up interference to use as a cancelling signal.

The main difficulty in designing a canceller is achieving the required adjustment of phase and amplitude. The latter is a matter of amplification and/or attenuation, which is not too difficult in practice, but the phase adjustment requires some ingenuity. Phase can be varied by using tuned circuits and exploiting the fact that the phase of the circulating currents in a tuned circuit change, relative to the exciting signal, as the circuit is tuned across resonance. A more convenient method is to use an arrangement where a signal is split into two parts, one part being shifted in phase by 90° relative to the other part; the two parts are then recombined. By adjusting the amplitudes of the shifted and unshifted signals, it is possible to achieve any phase shift between zero and 90°. By inverting (changing by 180°) either or both signals, any required phase shift is possible.

A design for a canceller using this principle was published some years ago in *QST* by W1ETC (October 1982). This circuit illustrates the technique very well, and will form a good basis for experiments with cancelling. The block diagram and circuit are reproduced in Figs 7.18 and 7.19. The 90° phase shift is achieved by using a length of coaxial cable cut to be a quarter-wave at the frequency of interest ï not forgetting to allow for the velocity factor of the cable. Fortunately, in practice there is a fair amount of latitude in the cable length so that it is possible to cover more than one band with a particular length. It may be wondered why the relatively high-power amplifiers are used in a receiving circuit; this is an example of using high-power devices to minimise problems from intermodulation.

Where the requirement is to eliminate local interference, one of the antennas is usually the main station antenna, and the other (the auxiliary antenna) is a relatively simple arrangement, sited to pick up the interference as well as possible. If more controlled experiments are to be carried out, the wide bandwidth and inherent matching of an active antenna make this a good choice for the auxiliary antenna.

All this talk of exactly adjusting the phase and gain may give the impression that cancellers will only operate in ideal conditions. This is far from the case: in fact they will give a good account of themselves in almost all situations ï the only requirement is that there must be sufficient amplitude/phase adjustment to cover the range of signal to interference conditions. It is also important to remember that, by its very nature, such a device can only cancel one signal at a time. If the interference is coming from more than one source, or arriving at the station by more than one route, as with ionospheric signals, the cancellation will be limited. In good conditions cancellers can be extremely effective, giving nulls of 60dB or more.

Peusdo-random data signals which give the effect of white noise, can be cancelled, but have the difficulty that there is nothing distinctive to listen to. The best technique is to use the S meter to get as deep a dip as possible. Hopefully by then the noise will have reduced to a level where signals will be audible, and final adjustment can be made for best signal and minimum noise.

The one type of interference which the canceller will not cope with is natural static. This is because the crashes of natural static come from different locations, so that even if it were possible to cancel one crash, the adjustment would not be suitable for the next one, and it would get through more or less unaffected.

Information on HF cancellers has appeared in a number of articles including Technical Topics RadCom March 1993. A design for a VHF canceller can be found in RadCom April 1992 and September 1992. Commercially manufactured interference cancellers are available, but there is no unanimity about what to call them, so it is important to make sure that the device you are purchasing is what you are looking for.

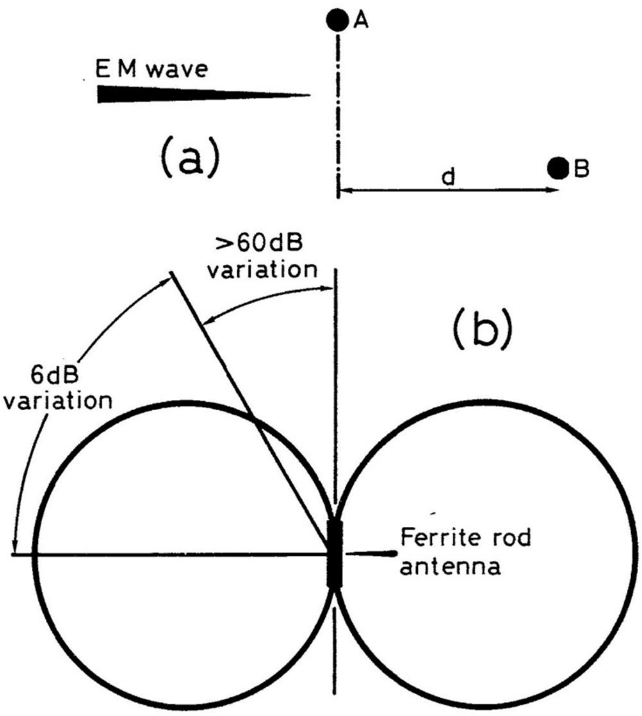

Fig 7.17. (a) An electromagnetic wave arriving at two antennas. The signal at B will be delayed in phase by the time taken for the wave to traverse the distance d. (b) The response of a ferrite-rod antenna. The change of signal strength near the null is quite large. Away from the null the change is quite small

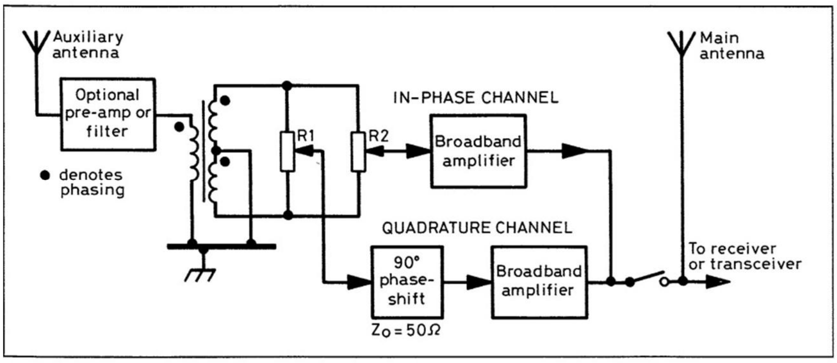

Fig 7.18. Block diagram of a canceller (*QST* October 1982)

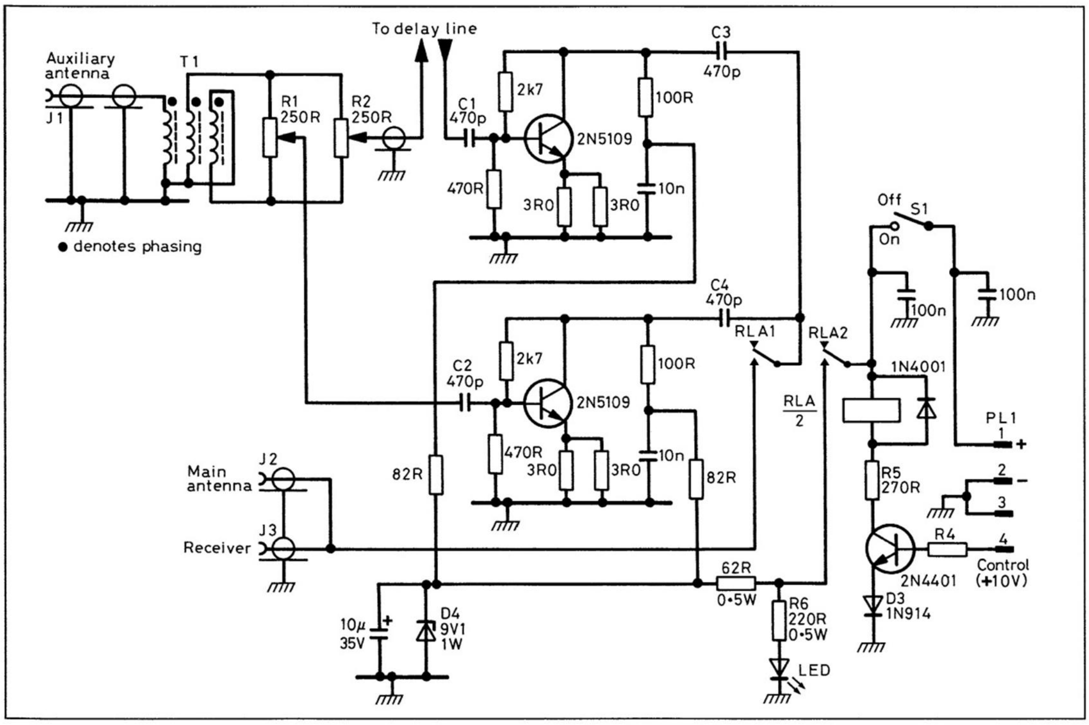

Fig 7.19. Circuit diagram of the canceller. R1/R2: linear carbon potentiometers. T1: 5 trifilar turns. Core: Palomar F37-Q2 or Amidon FT37-63. Note that the circuit around RLA (R5, D3, R4 and the 2N4401 transistor) should be adapted to suit the available relay. The circuit shown is suitable for receive only or for a low-power transceiver. For high power a more substantial relay will be required