Eliminate troublesome whistles from your AM tuner

9kHz Whistle Filter

Since AM broadcast stations in Australia are now spaced at 9kHz intervals, the problem of heterodyne whistles is more severe than before. The whistle filter featured here was originally designed to suit the new Playmaster Digital AM/FM Tuner, but will suit virtually any tuner with a 9kHz whistle problem.

by LEO SIMPSON

Previously, with the 10kHz AM station spacing, whistles were not a problem unless the listener had a tuner of reasonable bandwidth, loudspeakers of fair quality and ears of equally fair acuity. Now, however, with 9kHz AM station spacing, tuners of only modest bandwidth can present even less sensitive ears with a whistle problem.

Whistles will normally be more noticeable at night, when reception conditions are improved. This allows distant stations to be picked up with sufficient strength to cause interference with local stations. If you listen to the radio only during the daytime, it is unlikely that you will notice any whistle problem.

How does the 9kHz whistle become audible? This is best understood by a brief consideration of the superheterodyne principle which is used in most radios. After passing through a tuned input circuit (which may involve a ferrite rod aerial) and perhaps an RF stage, the incoming radio frequency is mixed with the local oscillator of the radio to produce an intermediate frequency of 455kHz.

The 455kHz signal is amplified in one or more IF stages and then passed to a detector, which is usually a diode, to recover the amplitude modulation. A simple RC filter removes most of the rectified 455kHz signal to leave the audio modulation.

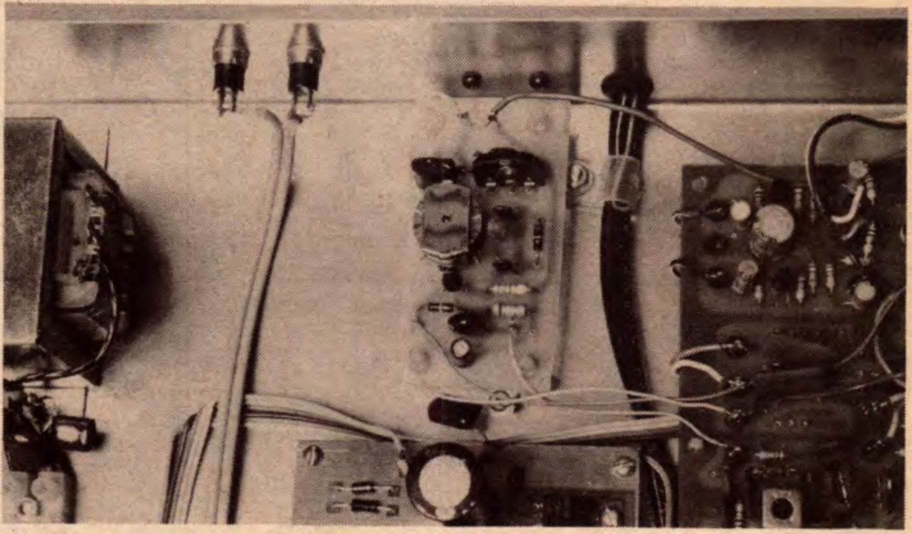
When two stations separated by 9kHz are received and fed together to the mixer, any sum and difference products other than those close to 455kHz are removed by the following IF stages. But if the tuner has a bandwidth of say, 10kHz at the —3dB point, the IF stages will pass frequencies between 445kHz and 465kHz.

So if the desired incoming station beats with the local oscillator to produce 455kHz, the interfering station 9kHz away will produce 464kHz (or 446kHz) as the beat product. These two frequencies, 455kHz and 464kHz are each amplified to the same extent in the IF strip and then rectified in the detector.

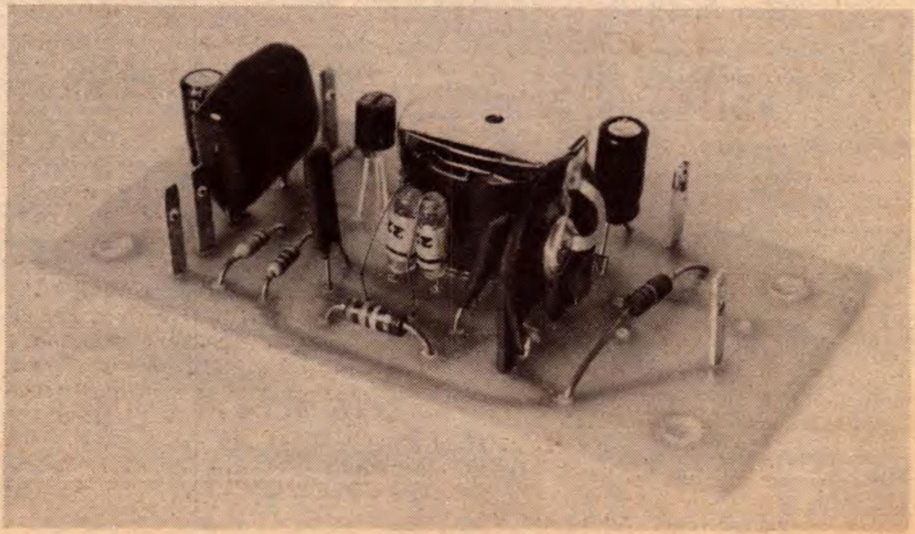
Since the detector is a non-linear device, the two frequencies are not only rectified but they are mixed to produce sum and difference frequencies. The sum frequency is removed by the RF filter following the detector, but the difference frequency is 9kHz! Thus it is amplified and fed to the loudspeaker in the normal way.

This problem is solved by inserting a notch filter in series with the output of the detector. The idea is to remove as little of the wanted audio signal as possible, but introduce very high attenuation at the undesired frequency, namely 9kHz.

The whistle filter described here uses a high-gain, low-noise transistor connected as an emitter-follower driving a bridged-T network. As used here, the bridged-T network is essentially a parallel-tuned circuit. At resonance, the parallel-tuned circuit is a very high



Above is shown the whistle filter installed in the recently described Playmaster AM/FM tuner. Below is a 19kHz version of the filter.



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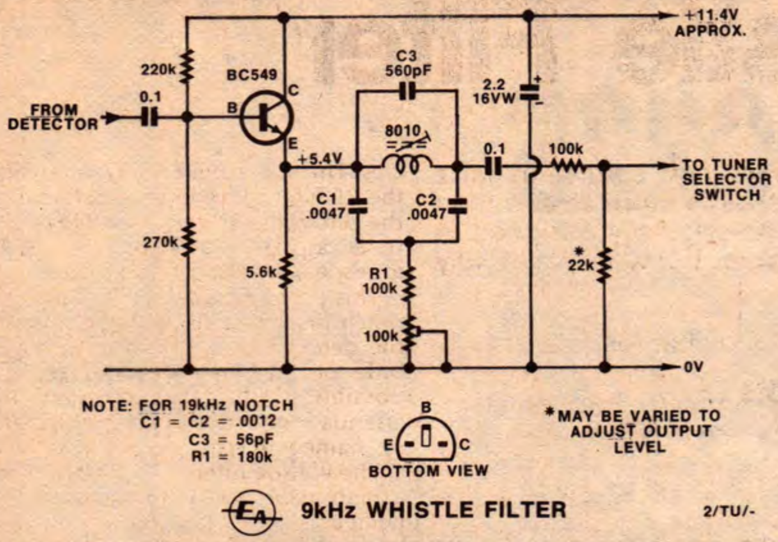
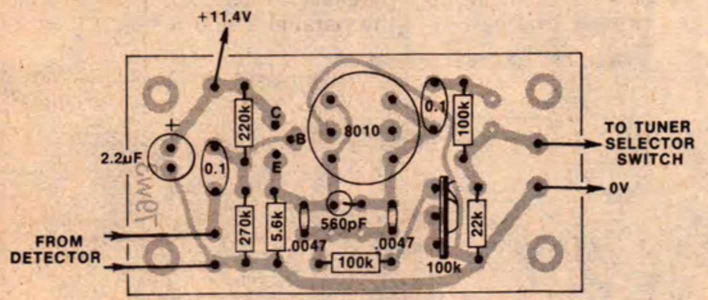
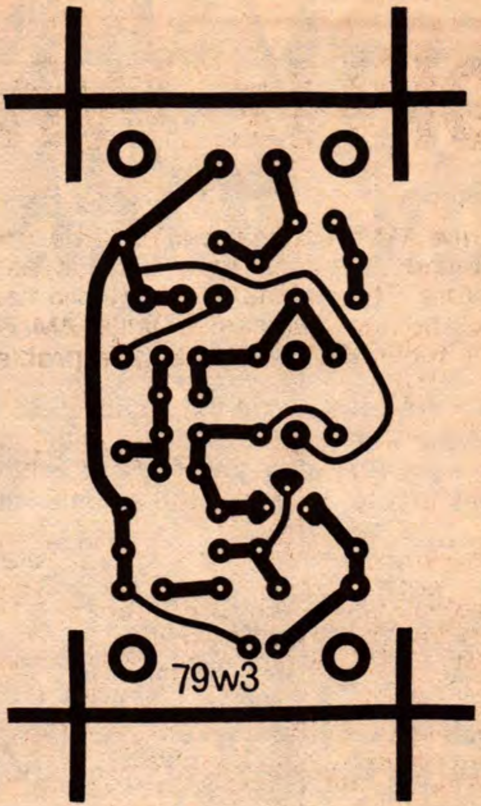


The circuit is an emitter-follower driving a bridged-T network.





Above is the actual size artwork for the PCB while at left is the component layout for the PCB.

PARTS LIST

1 PC board, 79w3, 40 x 78mm
1 BC549 low noise NPN transistor
1 Jabel 8010 whistle filter coil
1 2.2uF/16VW PC electrolytic
2 0.1uF metallised polyester (greencap)
2 .0047uF metallised polyester (greencap)
1 560pF polystyrene capacitor
Resistors (¼W, 10% tolerance):
1 x 270k, 1 x 220k, 2 x 100k, 1 x 22k, 1 x 5.6k, 1 x 100k preset potentiometer
5 PC pins or stakes

impedance. The adjustable resistor centre-tapped into the capacitive arm of the circuit produces a small phase correction to compensate for the losses in the inductive arm.

The inductor is adjusted to give resonance at precisely 9kHz and the adjustable resistor optimises the null.

As noted above, the whistle filter may be installed in any AM tuner and can be run from positive supplies up to 30 volts DC with no modifications, apart from changing the voltage rating on the 2.2uF electrolytic capacitor.

The circuit is accommodated on a PC board measuring 40 x 78mm, and coded 79w3. Assembly is a straightforward matter requiring little comment.

The whistle filter coil has a nominal inductance of 107 millihenries and is wound on a Neosid ferrite potcore. Made by Transcap Pty Ltd, it is distributed by Watkin Wynne Pty Ltd, 32 Falcon Street, Crows Nest, NSW 2065 under the "Jabel" brand, type 8010. As it has a current retail price of more than $8, we are delighted to report that only one is required!

When the PCB is complete and installed in the tuner, the inductor is adjusted for maximum null by rotating the top section. This has the effect of varying the air gap between the core sections, and thus adjusts the inductance. Since the null obtainable is very sharp, the adjustment is quite critical. Nevertheless, it is possible to obtain a null of more than 50dB using your ears.

Accurately tune to a station which has a 9kHz whistle (at night), boost the treble and volume controls on the amplifier if necessary and adjust the inductor and 100k preset pot for the best null.

The alternative method, using instruments, is actually more difficult. A low distortion oscillator which can be set accurately to 9kHz within ±10Hz is required. If the null is to be better than 50dB down, the oscillator distortion must be less than 0.3%. This is because, when the null is measured, with an oscilloscope or millivoltmeter, the reading is actually the harmonic distortion of the oscillator and buffer stage.

If you have access to an accurate, very low distortion oscillator it is possible to adjust the circuit for 9kHz rejection of 75dB or more.

The circuit may also be used as a 19kHz filter for FM tuners. Two PCBs will be required in this case, one for each channel. The three capacitors and fixed resistor in the bridged-T network need to be changed as follows: C1 = C2 = .0012uF; C3 = 56pF and R1 = 180k.