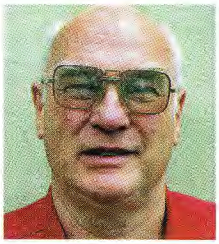
VINTAGE RADIO



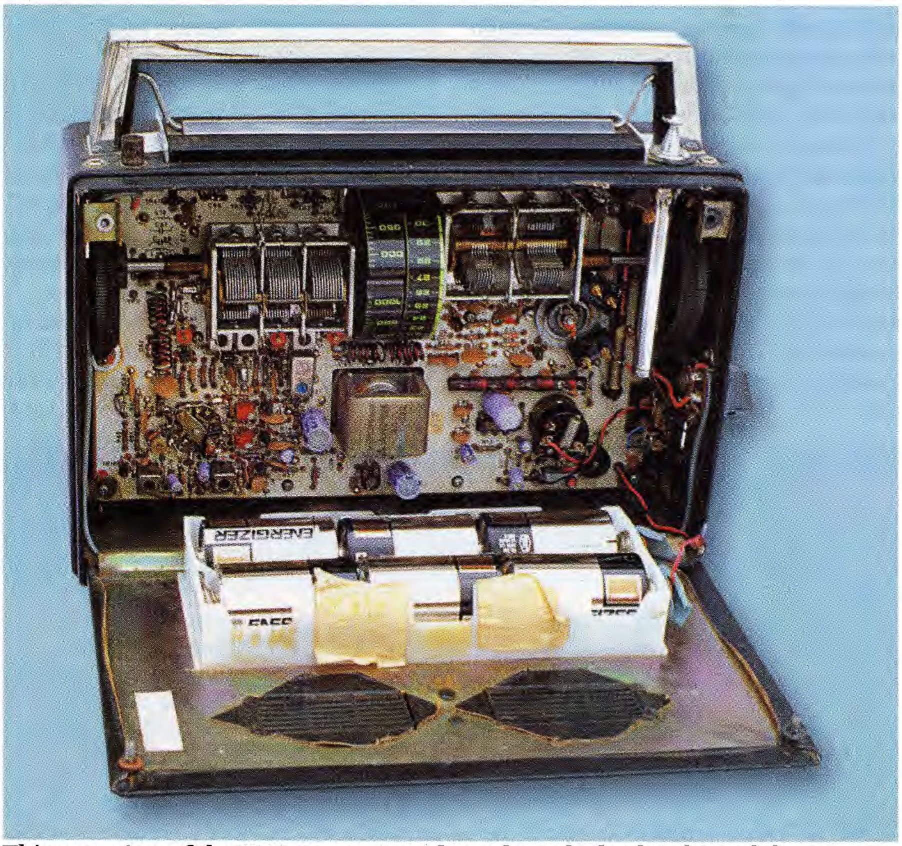
By RODNEY CHAMPNESS, VK3UG

The Barlow Wadley XCR-30 MkII communications receiver

Developed during the 1960s, the Barlow-Wadley Loop principle gave rise to a new generation of up-market communications receivers. Here's a look at one such set and how it operated.

The Barlow Wadley XCR-30 multi-band receiver was made by the Barlows Manufacturing Company Ltd in the Republic of South Africa between 1969 and 1981. The model number "XCR-30" indicated that it was a "crystal-controlled receiver with 30 bands".

This was a relatively rare receiver in Australia, despite the fact that about 20,000 of them were produced. The reason for this is quite simple: Australia (and many other nations) boycotted products from South Africa during that period due to the latter's apartheid policies. However, some of these advanced receivers did make it to Australia and I was fortunate enough to obtain one for personal use (I used them in my work as well).



This rear view of the XCR-30 receiver shows how the back is hinged down so that the batteries can be replaced.

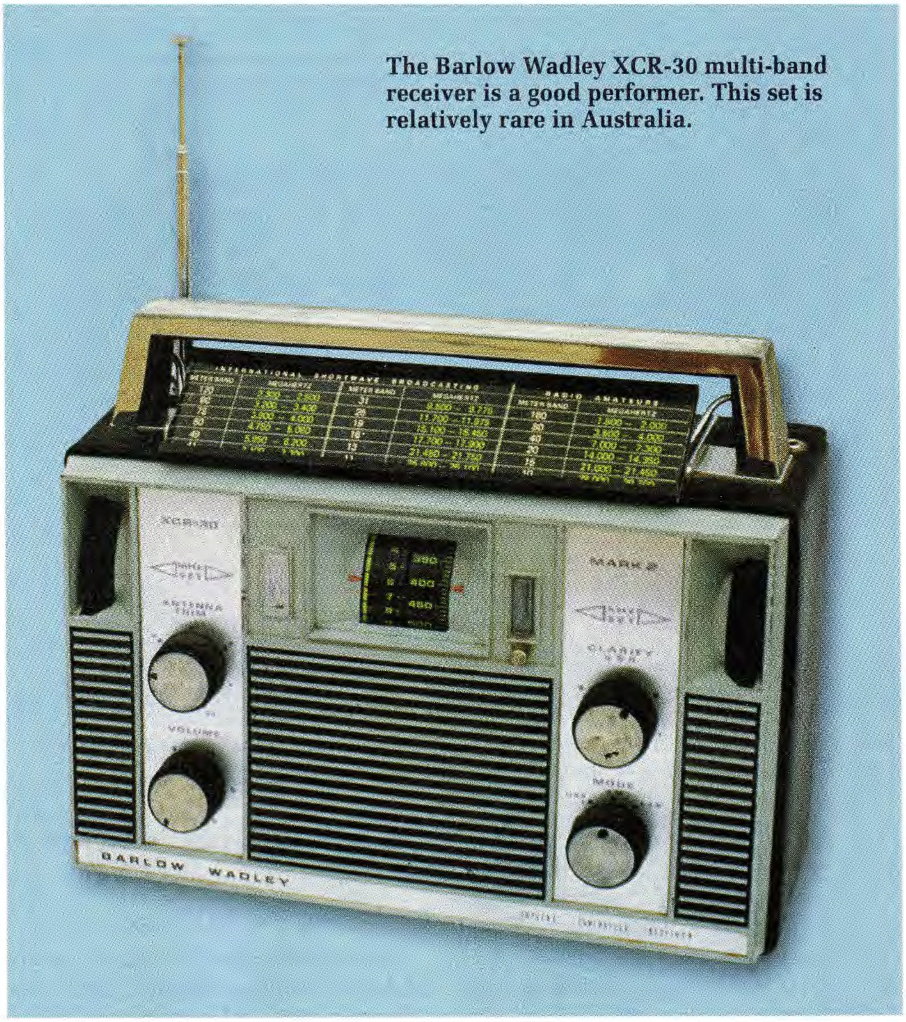
They were not cheap, selling for around $225 in 1975. The first model arrived in late 1970 and subsequent upgrades occurred until at least 1974. I believe that an FM converter was also made to work with the receiver but I've never seen one of these.

At first glance, the set appears to be just another large multi-band portable receiver with a telescopic whip antenna. This is true, of course, but on closer inspection it becomes evident that the set is more than just a multi-band transistorised portable radio. It has a total of 31 bands and tunes from 500kHz to 31MHz in 1MHz segments. And it has the ability to tune AM, single sideband (SSB) and Morse code (CW) signals.

Furthermore, its dial calibrations are quite accurate and it is an extremely stable receiver which exhibits only very slight drifts in the tuned frequency, even at 30 MHz. This means that you can tune to a frequency up around 30MHz and be confident that an AM station on that frequency will be heard as soon as it commences transmission, without the need for retuning. It is not quite as stable as this on SSB, however.

Construction

The set itself is mounted in a steel case which provides reasonable shielding for the electronic circuitry. This case measures 292mm wide by 190mm high by 98mm deep and is



The Barlow Wadley XCR-30 multi-band receiver is a good performer. This set is relatively rare in Australia.

covered with black vinyl over foam plastic sheeting. It also weighs in at just over 4kg with batteries, so it's hardly a "lightweight".

The physical appearance of the set puts it somewhere between a domestic entertainment portable and a professional receiver. And realistically, that is what the set's market segment is – sub-professional.

Sensibly, the manufacturers provided a decent-sized source of power in the form of a pack of six D-cells. The set can also be used with an external 6-12VDC power supply via a 2.5mm DC socket. This was then regulated to around 6.5V in most instances, with the set protected against reverse polarity by a germanium diode.

Strangely, the set has a positive earth which means that it cannot easily be used with a supply with a negative earth, as in most vehicles. Most of the transistors in the radio are NPN silicon types, with just a sprinkling of germanium PNP types, so you would think that a negative earth would have been used.

A 3.5mm miniature phone socket is mounted alongside the power socket and this can drive either an external speaker or headphones. The antenna used for all frequencies is an 870mm-long telescopic whip.

An interesting feature is the use of electronic band changing, thus eliminating the need for a very complex 31-position mechanical switch. To tune the set, the lefthand dial (bandswitch if you like) is set to the particular Megahertz range required and the righthand dial is then rotated until the desired station is heard. For example, Radio Australia on 9580kHz would be tuned by setting the MHz dial to "9", then the kHz dial to "550", then three more small divisions further up the dial brings the set to 9580kHz.

Even if the transmitter wasn't operating at that time, the station would be heard as soon as it commenced operation. How many portables of the early 1970s could boast that degree of tuning accuracy?

The other controls are more conventional. The on-off-volume control is quite conventional, for example. An antenna tune control was a feature of a number of portable receivers (particularly imported multi-band types) and this Barlow Wadley receiver has one too. However, it tunes from 0.5-30MHz in one sweep of the control. The control is either rotated to obtain the best quality signal or if there is no signal, is peaked on the background noise.

As mentioned earlier, the set is multi-mode, being able to resolve SSB and CW signals in addition to AM. As a result, a mode switch is included on the front panel. Its left position selects upper sideband, the centre position AM and the right position lower sideband. In the sideband positions, Morse code (CW) can also be resolved.

Tuning SSB signal is quite critical so the knob above the mode switch is an SSB clarifier. This latter control is used to accurately tune SSB for clear reception.

Performance

Because it is so different from anything else of the era, it is interesting to see how this rather sophisticated receiver works.

The six D-cell batteries are fitted by first undoing two screws on the top edge of the back using a screwdriver or a small coin. The back can then be laid down, after which the cells can be inserted into the holder. Note that the back can also be completely removed by lifting it out of the gutter at the bottom of the cabinet, while the battery connections can be removed from the battery holder.

Once the antenna has been fully extended, the broadcast band is a good place to start our check on the performance of the set. Let's say that we want to tune to 693kHz. First, the set is turned on and the volume control rotated part way. The antenna trim (tuning) is then set to approximately the position where 693kHz would be (this is a vague setting).

Next, the megahertz dial is set at "0" and the kilohertz dial is rotated until it is just below "700". The mode switch should be in the AM position. If the station is within range, it should now be heard.

It is then necessary to peak the "Antenna Trim" and adjust the MHz and

This view shows the front of the receiver with the front panel removed. The 1MHz crystal oscillator is shown at the top left of the photograph.

kHz dials for best reception. The small signal-strength level meter, just to the left of the frequency setting dials, gives an idea of the relative strength of received signals. Once it's tuned, you can adjust the volume control to the desired level.

Although a bog-standard transistor set may perform well on 693kHz, the Barlow Wadley is a bit disappointing at this end of the dial. However, the higher the frequency tuned, the better the receiver performs. In fact, its performance is sparkling in the higher shortwave regions and it will outperform most receivers of the era on its whip antenna.

What's more, it doesn't drift off station and has good dial calibration. Even on SSB stations, it will remain in tune for considerable periods of time. The audio quality is also good and with around 400mW into its 100mm speaker, the volume is adequate for most situations.

Another feature of the set is the provision of separate antenna and earth terminals. These can be used to improve the reception at low frequencies and the use of an external antenna does help in this regard. However, I was still not satisfied with the performance, so I modified the antenna circuit to improve the reception. We'll take a look at this modification later.

Restoring the XCR-30

Not surprisingly, the cabinet on my set has suffered a few blemishes over the years but is otherwise intact. The grille also has a number of marks and I'm not sure whether I can remove them without doing further damage.

Internally, the set is well protected and damage is unlikely unless it is run over by a truck! Removing the rear panel gives access to a double-sided PC board of quite high quality. This board carries all the circuitry and has the component numbers marked on it, as well as five test points. However, without the service manual, identifying what does what is quite difficult, as this is not a conventional superhet receiver.

To really get serious about servicing this receiver, it is necessary to remove the front panel. First, the knobs are removed, followed by nine screws through the PC board. This allows the front panel to come away and you now have access to both sides of the board, which is great for servicing.

Speaking of servicing, these receivers have a common fault in the VHF sections of the circuit. This is due to the fact that quite heavy enamelled-copper wire is used for the coils and transformers (this was done to maintain alignment stability and to ensure a stable tuning range for the VHF oscillator). However, because these parts are so heavy, they tend to break the solder joints and tracks on the back of the board.

As a result, it's a good idea to resolder these areas of the board, as this seems to fix most problems.

How it works

As already mentioned, this receiver isn't a conventional superhet, so let's see how it works.

At the antenna input, the signal is coupled via a low-value capacitor to the top of one of three antenna coils. These three coils are switched in or out of circuit by two microswitches and are tuned by a ferrite slug attached to the dial cord. As the dial cord moves, this ferrite slug is slid through each of the coils in turn, the proximity of the slug also triggering the relevant microswitch.

This nifty idea means that the antenna can be peaked anywhere between 500kHz and 31MHz with just one sweep of the antenna trim control. The tuned signal is then amplified and applied to a diode balanced mixer (converter), where it is mixed with the VHF local oscillator signal (tuning range 45.5-75.5MHz) to give an output at 45MHz ± 650kHz. This is then applied to a 45MHz broadband IF amplifier.

This high first IF (intermediate frequency) permits the use of relatively simple RF circuitry in the front-end while still achieving very good image response (and there's no complicated 31-position band switching). With a 13.7MHz input signal (MHz dial set to "13" and the kHz dial set to "700"), the image is at 103.3MHz. The 13.7MHz signal beats with a 58.5MHz local oscillator signal, giving an output on 44.8MHz.

Note that the 45MHz IF channel is quite broad in response and will ac-

Fig.1 (right): this is the full circuit diagram for the Barlow Wadley XCR-30 MkII communications receiver. It has a no less than 31 bands, tunes from 500kHz to 31MHz in 1MHz segments and can receive AM, single sideband (SSB) and Morse code (CW) signals.

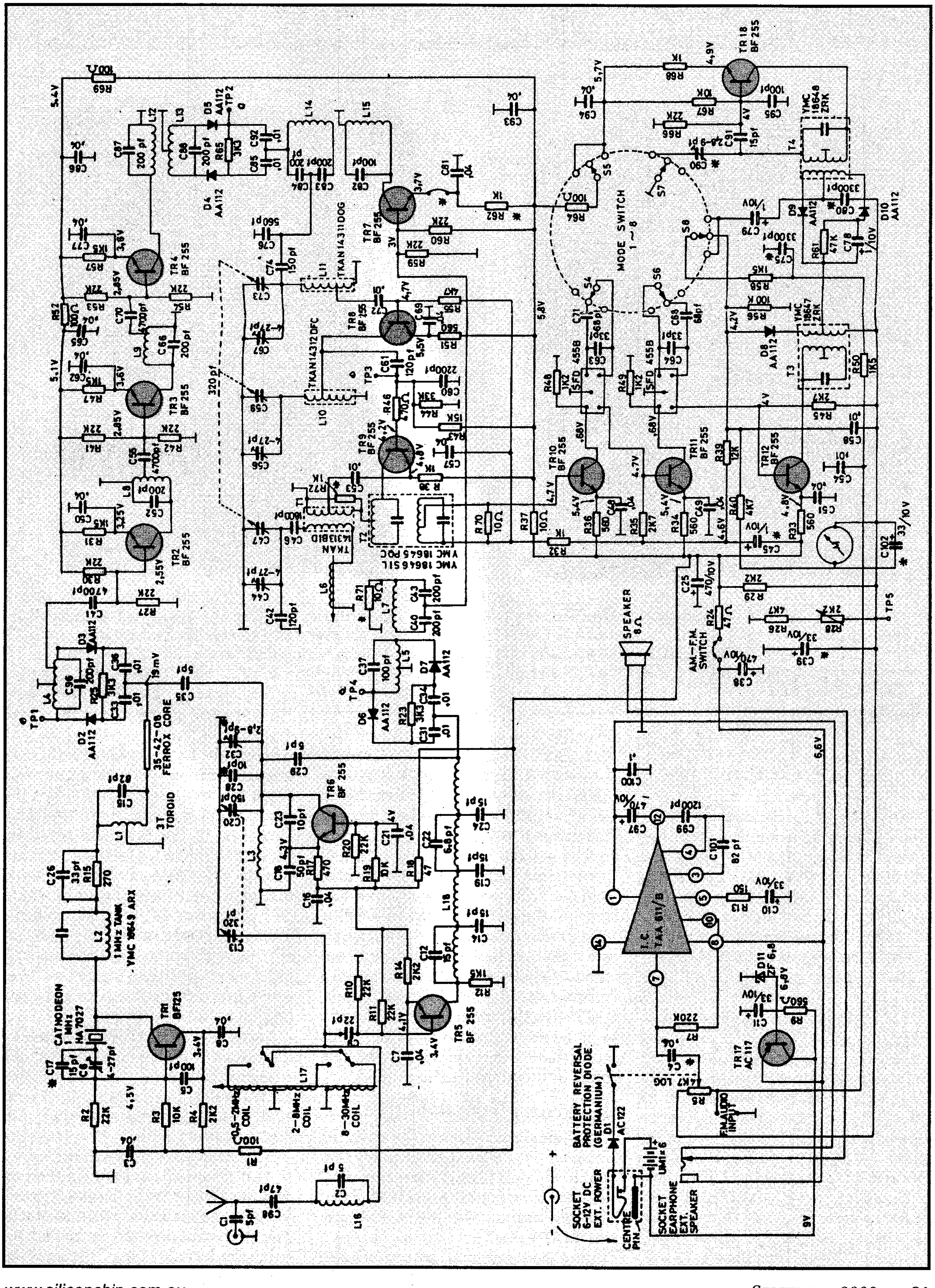

MODE SWITCH 1 — 8
SPEAKER 8Ω
AM—F.M. SWITCH
BATTERY REVERSAL PROTECTION DIODE. (GERMANIUM)
SOCKET 6-12V DC EXT. POWER
SOCKET EARPHONE EXT. SPEAKER
CENTRE PIN
CATHODEON 1 MHz HA7027
1 MHz TANK YMC 18649 ARX
35-42-06 FERROX CORE
3T TOROID
0.5—2MHz COIL
2—8MHz COIL
8—30MHz COIL
FM AUDIO INPUT
I.C. TAA 611/B

Photo Gallery: Airzone Models 529 & 511

The Airzone Model 529: this was an AC/DC broadcast-band receiver with the following valve line-up: EK2 converter, CF2 RF amplifier, CBC1 detector/audio, CL2 output, CY2 rectifier and C1 ballast. (Photo courtesy Bill Adams, VK3ZWO).

The Airzone Model 511: this AC broadcast-band model featured a circular dial and carried the following valves: 6A8 converter, 6K7 RF amplifier, 6Q7 detector/audio, 6F6 output and 5Z4 rectifier. (Photo courtesy Bill Adams, VK3ZWO).

cept signals from around 44.35MHz to 45.65MHz (1.3MHz bandwidth) with little attenuation.

Next, the 44.8MHz signal is amplified and applied to another diode balanced mixer on 42.5MHz. This produces an output on 2.3MHz (44.8MHz - 42.5MHz = 2.3MHz). An image of the 44.8MHz signal would occur at 40.2MHz but will be insignificant due to the selectivity of the 45MHz IF amplifier and the very high frequency of the image response at the first mixer.

The signals at the input of the 2-3MHz tuneable second IF amplifier cover a whole megahertz, so it is necessary to tune this stage to 2.3MHz. This section of the receiver can be considered quite standard. In this particular scenario, all the signals in the range 13-14MHz can be selected as desired by the tuneable IF (kHz dial).

However, it is possible to have breakthrough of an image signal which is located 910kHz (ie, twice the IF frequency) higher than the wanted signal. Thus, a signal on 2050kHz will have an image at 2050 + 910 = 2960kHz. To overcome this problem, an RF amplifier stage makes sure that the image is rejected.

The 455kHz amplifier (3rd IF amplifier) is straightforward. It only uses one conventional IF transformer and most of the selectivity is achieved by two ceramic resonators. The signals are then applied to a conventional diode detector for AM signals, or to a product detector for SSB/CW signals.

Finally, the signals are amplified by a conventional audio amplifier. This consists either of discrete transistors or an audio amplifier IC.

Local oscillator stability

Although the VHF oscillator in the receiver is stable, it's certainly not stable enough for SSB (or even AM) reception without the received signal drifting well outside the passband of the IF amplifier.

In a conventional broadcast-band receiver, the local oscillator drifts over time and this may be as much as 5kHz when the oscillator is on 1500kHz (ie, for a tuned frequency of 1045kHz). However, in the Barlow-Wadley receiver, the oscillator for the first mixer may be on 75MHz and if it suffered the same percentage of drift, it would drift 50 times as far – ie, 250kHz. That's not good as it would mean that the dial calibrations would be out and, even worse, just moving the set ever so slightly would completely detune SSB signals.

Fortunately, the drift in the oscillator is noticeably less than this but in a conventional receiver, it would still be too much for listening to AM or SSB without having to regularly adjust the tuning.

So how is the VHF oscillator set up so that it remains exactly on the correct frequency? Well, that's not possible but it is made as stable as practical. Any drift is then corrected for using the "Wadley Loop" principle so

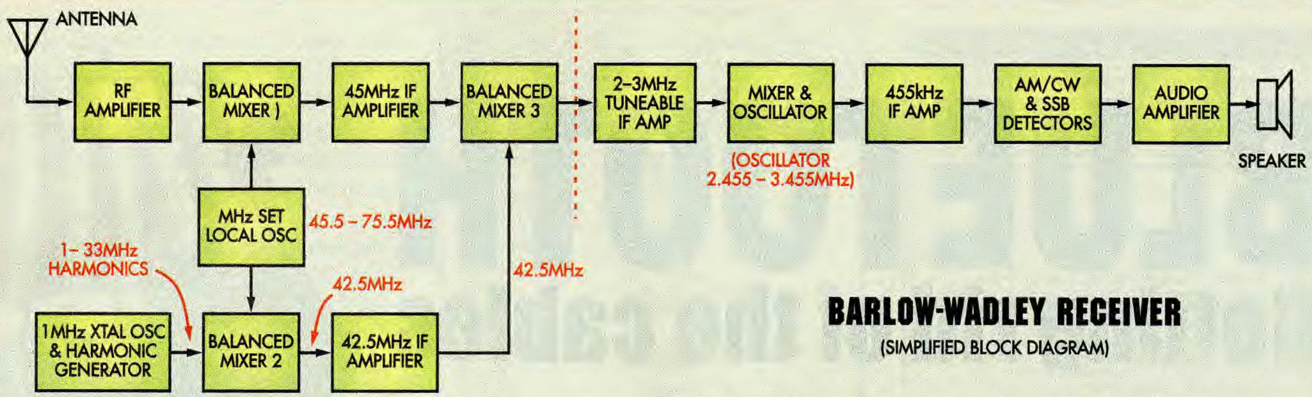


Fig.2: this simplified block diagram will help you understand how the Barlow-Wadley Loop works. Follow it in conjunction with the description given in the text.

let's see how this works.

Fig.2, which is a block diagram of the receiver, will help you understand the basic principle. As shown, a 1MHz crystal oscillator is incorporated into the receiver and its output is processed in an harmonic generator to provide harmonics extending beyond 33MHz. It also sets the 1MHz tuning range for each band.

The VHF local oscillator tunes nominally from 45.5-75.5MHz and whenever its output minus an harmonic of the 1MHz oscillator equals 42.5MHz, a particular band is selected.

For example, if the receiver is tuned to the 13MHz band, the oscillator will be on 58.5MHz. This 58.5MHz is mixed with the 16th harmonic of the 1MHz crystal oscillator in balanced mixer 1. This gives 58.5 - 16 = 42.5MHz which is then fed to a 42.5MHz IF amplifier stage.

Note that this IF amplifier does not amplify the received signal – instead, it amplifies only the 42.5MHz mixing product of the two oscillators. This 42.5MHz "local oscillator" signal then mixes with the band of signals centred on 45MHz in balanced mixer 3 to give signals in the 2-3MHz range as previously explained.

Earlier in the article, an example of a received frequency of 13.7MHz was used. It mixed with 58.5MHz (mixer 2), giving a 44.8MHz output (45MHz IF). This was then mixed with the 42.5MHz signal to give 2.3MHz. This is the case where the VHF oscillator is exactly on 58.5MHz.

But what if the VHF oscillator drifts to 58.6MHz? The signal in the 45MHz IF will now be on 44.9MHz and if mixed with 42.5MHz, the tuneable IF stage would need to be reset to 2.4MHz. And that's quite unsatisfactory, as this would mean that the kHz dial would have to be retuned.

However, all is not lost. The 58.6MHz signal is mixed with the 16MHz signal from the crystal oscillator and gives an output of 42.6MHz which is still within the passband of the 42.5MHz IF amplifier. This 42.6MHz signal is then mixed with the 44.9MHz IF signal (mixer 3) and this gives an output of 2.3MHz.

This is exactly the same as when the VHF oscillator was on 58.5MHz. So even though the oscillator has drifted 100kHz, the Wadley loop system has cancelled this drift out. The VHF oscillator can therefore drift ±150kHz (the acceptance bandwidth of the 42.5MHz IF amplifier) and the front end of the receiver will still have crystal-locked frequency stability!

All in all, it's a very nifty way of cancelling the VHF oscillator drift.

Improving sensitivity

Because I was dissatisfied with the sensitivity of the receiver at low frequencies, I decided to install conventional primary windings over the aerial coils. First, some 20 turns of 36-40 gauge enamelled copper wire was wound at the earthy end of the 0.5-2MHz aerial coil. One end of this coil was soldered to the nearby PC board earth and the other to a 3-position single-pole switch mounted near the headphone socket.

The 2-8MHz coil had 7-8 turns wound onto its earthy end and the active wire was also taken to the 3-position switch, while the other end went to the PC board earth, as before. These new primary windings were held in place with a dab of nail polish.

The 8-30MHz coil was directly tapped at the seventh turn from earth and this tap was taken to the third position on the switch. The moving contact of the switch was then connected via a thin coaxial cable to a BNC cable socket mounted near the earth terminal. These simple modifications greatly improved the performance on the lower frequencies. **SC**