By Ian Batty

Adelaide-made National AKQ Walkabout portable

Well before the advent of smartphones, if you wanted entertainment on the go, you would carry a transistor radio in your pocket. It let you keep up with news, sport and the doings of the world. Before that, in the 1950s, it wasn't quite so easy. But you could still bring entertainment with you, in the form of the Walkabout radio.

I bought this set at an HRSA auction in 2015, attracted by its unusual appearance. Since an all-metal case would have prevented signal pickup, I wondered how the designers made it work. It took me some time to figure out what it was, as there is no apparent manufacturer's mark. The Ducon capacitors and Philips-branded valves told me that it was made somewhere in Australia.

A fellow HRSA member told me it was made by National, in Adelaide, confirmed by the newspaper advertisement shown later in this article. I went to **www.radiomuseum.org** and found a National set from 1948 listed, the AKQ, but with no circuit diagrams or photos.

Two similar radios

I emailed Kevin Chant and he helpfully sent me a copy of the circuit diagram and alignment guide, from the 1947 Australian Official Radio Service Manual (AORSM), on page 333.

The AKQ is based on the Astor KQ, except that the KQ is in a more conventional "lunchbox" case with a standard loop antenna in the flip-up lid. There are a few other component variations between the two.

It's a four-valve set with the usual lineup of a 1R5 converter, 1T4 IF amplifier, 1S5 demodulator/audio preamplifier and 3S4 audio output stage. But it's just unusual enough to be interesting. And it works pretty well, too.

National's circuit shows the converter's anode connecting to HT through the IF primary, then via item 24 (a 10kΩ resistor) to the screen and HT. This is wrong; the circuit diagram presented here has been corrected. Astor's KQ circuit is correct and easier to read. National's drawing office followed Astor's simple component numbering principle (#1, #2, etc).

Both the National and Astor circuits show voltage readings for a 1kΩ/V meter, but the readings shown for the 1S5 screen and 3S4 grid are misleading – a 1kΩ/V meter would have given much lower readings at these points and would not give a useful measure of circuit function.

The AKQ Walkabout and the Astor KQ share a rather odd supply switching arrangement: the LT positive end is switched, but the HT supply's negative end is switched. Most component values are identical between the two sets.

The principal differences are the cabinets and the KQ's use of a conventional, multi-turn frame antenna. The KQ service notes are comprehensive, and the circuit diagram is much better laid out and more legible.

Construction and restoration

It's a conventionally constructed valve set, using valve sockets and tag strips mounted onto a pressed-and-punched steel chassis. It uses point-to-point wiring of rubber-covered single-strand tinned copper.

With age, some of the insulation had degraded and frayed off. Rather than pull it entirely to pieces, I replaced the worst of the wiring. The soldering quality was mediocre; the wires were not wrapped around the tags before soldering, although this did make component replacement easier.

The wiring around the audio stage was pretty cramped, making it hard to get test prods onto socket pins. Given the set's compact construction, though, such cramping is to be expected.

Valve removal and insertion can be a bit tricky. I found removal easiest by placing a thin screwdriver blade between the valve base and chassis, then easing the valve out. Replacement was sometimes accompanied by the utterance of magic spells known only to technicians and best not repeated here.

Circuit description

The circuit begins with #35 (aerial strap assembly), not shown on the AKQ circuit. It's a simple length of braided copper, stitched inside the leather carry strap.

The aerial strap feeds into the matched primary of antenna transformer #29. Given the small size of the almost-one-turn antenna strap, we need a bit of magic to boost the signal.

Transformer #29 does this admirably, using a combination of step-up ratio and tuned-circuit multiplication. It yields a gain of some 43 times. As the adage goes, the best RF stage is a good antenna circuit.

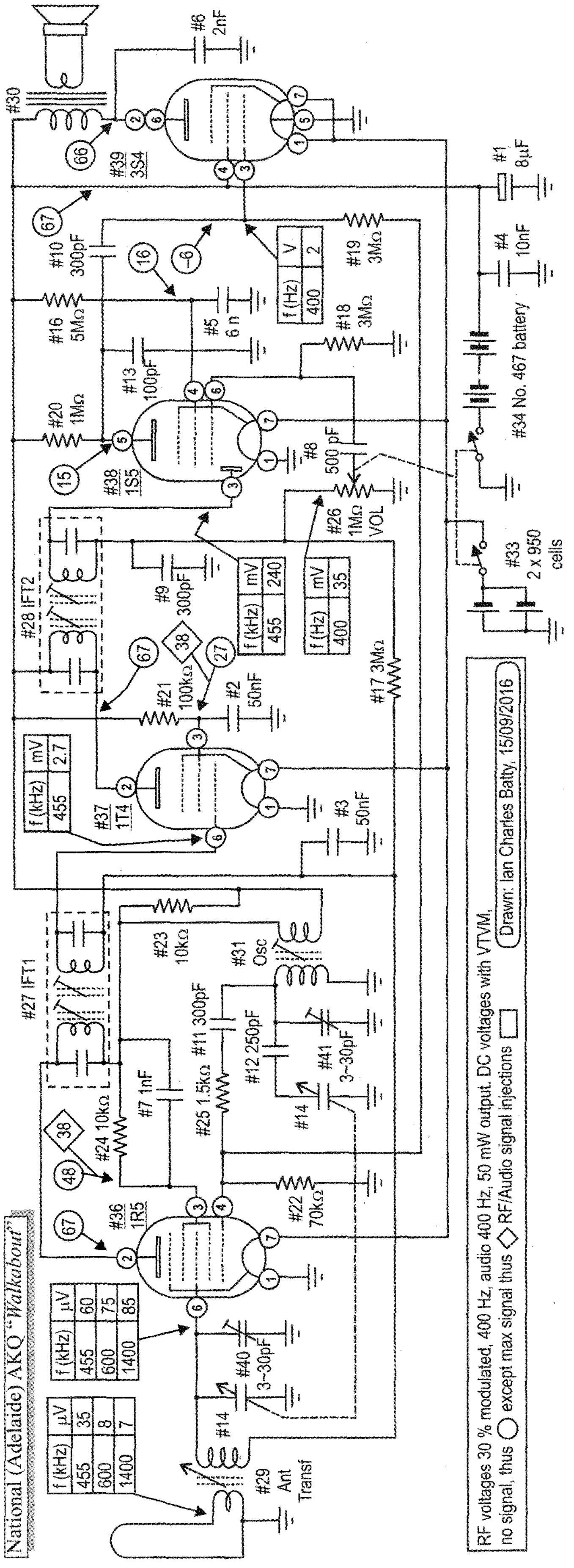
#29's high-impedance secondary feeds the aerial tuning gang and the converter's signal grid, grid 3 (pin 6). Converter #36 (a 1R5) is a pentagrid, modelled on the 6SA7/6BE6.

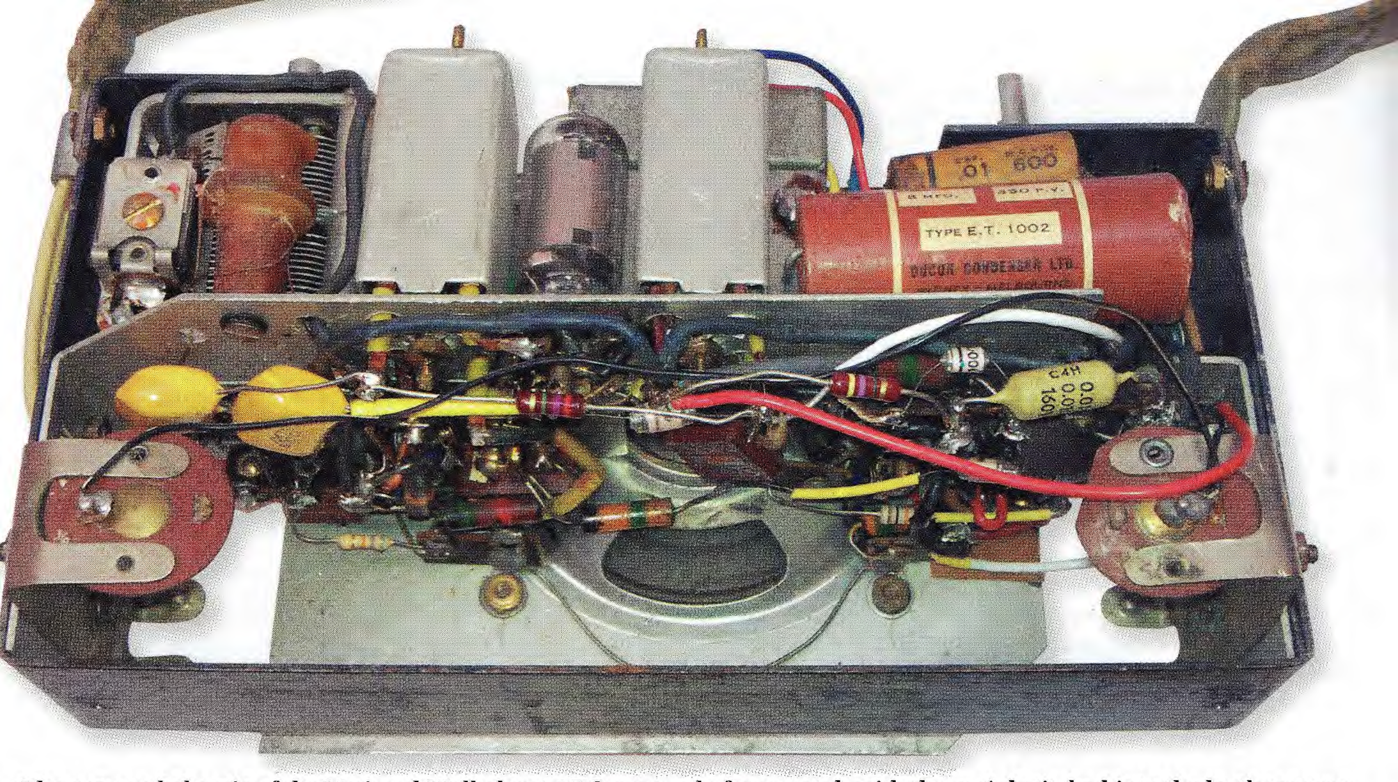
Grid 3 is used as the control grid while grid 5 (pin 2) acts as the oscillator anode. Grids 2 and 4 (pin 3) are tied together, isolating signal grid 3 from the oscillator section and ensuring that changes in grid 3's bias (due to AGC action) do not pull the oscillator off-frequency. So grids 2 and 4 act as screen grids.

Ideally, a screen grid is at RF/signal ground, so the preferred 6SA7/6BE6 converter design used a cathode-grid Hartley feedback circuit with a tapped oscillator coil. This allowed the combined screens (grids 2 and 4) to be bypassed to RF ground as you'd expect.

Since the 1R5 has no separate cathode, cathode feeding is complicated to implement. You'll usually see the screen grids (grids 2 and 4) carrying the oscillator signal and used as the oscillator anode, or (as in the Walkabout), the two screens and the anode "collected" at local oscillator (LO) frequencies to form the oscillator circuit's anode, drawing HT current through the oscillator coil primary.

Valve local oscillators work in Class C, where the grid is driven into conduction during the positive peak of the





The case and chassis of the National Walkabout AKQ are made from metal, with the aerial stitched into the leather carry strap. The components are connected via point-to-point wiring, making for a packed chassis when the batteries are included.

operating cycle, with anode current cut off at the opposite peak.

A novel output stage bias generation method

Driving the grid positive forces it into rectification, establishing an overall negative bias on the grid. It's usually a few volts negative, enough to pick off as bias for output valve #39 (a 3S4), via a 3MΩ resistor (#19). Bias for the output stage relies on a fairly constant LO grid current to generate a constant grid bias, and low (or no) LO activity will reduce or eliminate output stage bias.

On test, the bias voltage varied around -5V to -6V as the set was tuned from its low end to the high end. This bias is developed across the 70kΩ LO grid resistor (#22), with 1.5kΩ grid stopper (#25) aided by a 10kΩ resistor (#23) to give more constant LO activity and (hence) output bias.

The converter's anode drives first IF transformer #27, with conventional slug-tuned primary and secondary. The secondary feeds IF amplifier #37, a 1T4. This stage has an unusually high screen dropper (100kΩ; #21). 50nF capacitor #2 provides bypassing at intermediate frequencies (IF).

Starved screen IF stage

The 1T4 data sheet shows a screen voltage of 67.5V for an anode voltage of 67.5V, so this is a "starved screen" design. It's similar to the previously-described Astor Aladdin FG radio (August 2016; siliconchip.com.au/Article/10049). The FG, like many sets with two IF stages, uses the starved design to reduce gain and prevent IF feedback.

Astor's notes for the KQ describe it as a means of "reducing IF current drain". This reduces the potential total HT current by some 30%, but only reduces the potential gain by some 20%. So the reduced power consumption does appear justified.

The IF amplifier feeds the second IF transformer #28, also double-slug-tuned. Its secondary feeds the diode of diode/pentode #38 (pin 3), a 1S5. The rectified audio signal appears across 1MΩ volume control potentiometer #26 from the first grid of the 1S5 (pin 6), which also contains switching for the 1.5V LT and 67.5V HT supplies. 300pF filter capacitor #9 removes IF pulsations from the rectified output.

The AGC voltage is fed, via 3MΩ resistor #17, to the IF and converter control grids, and filtered to remove AC audio signals by 50nF capacitor #3. The pentode section of the 1S5 amplifies the demodulated audio and it is then fed to the output stage grid.

Audio preamplification stage

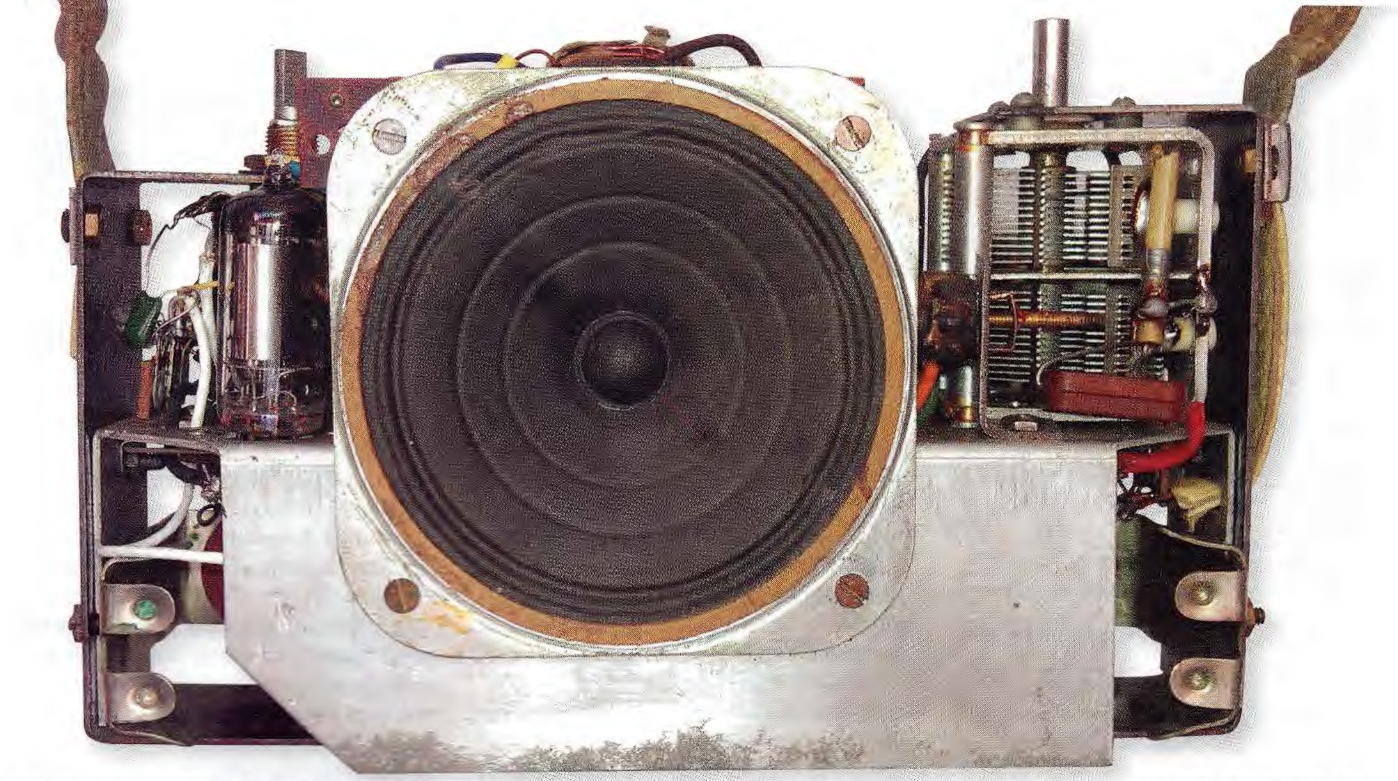
In common with first audio stages in battery radios, the audio amplification stage built around the 1S5's pentode uses "contact potential" bias. The relatively low value of grid resistor #18 (only 3MΩ rather than the more usual 10MΩ) allows the grid to drift negative due to the electron "cloud" surrounding the filament. This effect, though weak, is enough to provide a suitable bias for the 1R5.

The anode load resistor (#20) and screen dropping resistor (#16) values are quite high; 1MΩ and 5MΩ respectively. This combination, although only allowing an anode current just under 100μA, provides a stage gain around 50 times. The high value of #16 allows a low value for screen bypass capacitor #5 (6nF) compared to hifi designs using the indirectly-heated 6AU6.

Audio output stage

The 1S5's signal couples to output valve 3S4's grid. It's has a centre-tapped filament which allows it to operate from 3V or 1.5V (with the two halves in parallel). You'll see the 3V configuration used in series-filament designs.

The 3S4 needs a bias of around -7V, and the most obvious source is a back-bias resistor between the HT battery's negative connection and ground. It's a simple method, but it steals that voltage from the battery supply.



The case was made from Duralumin, and the chassis was likely made of a similar material. The speaker (likely a 4Ω Rola or equivalent) attaches to the chassis and to the other side of a board which also seats the output transformer.

Two alternatives exist: a separate bias battery (used mostly in military equipment with multi-voltage battery packs), or a tap from the local oscillator's grid bias resistor. As described above, tapping the LO's grid bias is a neat engineering solution.

The 3S4 feeds output transformer #30. The Astor KQ circuit has the core connected to the HT supply. Since this puts the fine wire of the primary at HT potential, any possible electrolytic corrosion of the primary is prevented. This technique is normally used only with "potted" transformers, for safety.

Finally, 2nF capacitor #6 is there to damp the output transformer's natural resonance. It's better connected directly across the primary rather than having one end to ground. If the capacitor goes short circuit, this may draw enough current to burn out the transformer primary.

Cleaning it up

The set was in good cosmetic condition, apart from wear on the leather strap. Electrically, it offered several challenges.

Turning up the volume, I was met by an ear-splitting shriek from about 20% to 75% of the volume pot's travel. Contact cleaner had a minor effect, so it had to be oscillation. I thought it might be due to capacitor #6 being faulty, as this is responsible for damping the output transformer's natural resonance. But putting another 2nF in parallel forced the set into even more violent oscillation.

It was odd that it only happened with the volume control over part of its travel. Holding a screwdriver blade onto the volume pot's wiper, and touching the insulated lead from the 3S4 output's anode lead with a finger, made it worse.

So I reckoned it was due to audio feedback. I tried putting in a new HT bypass capacitor but that made no improvement. I then shielded the audio leads from demodulator to volume control pot, thence to the 1S5 grid, also resulting in no improvement. I then connected one side of the speaker's "floating" voice coil to ground, with no improvement.

Having already replaced 100pF capacitor #13, I bit the bullet and added a 470pF capacitor from the 1S5 grid to ground. Since this would be in series with 300pF capacitor #10, it would potentially reduce coupling from the volume pot, so I increased capacitor #10's value to 4.7nF.

That solved the problem. Whatever bizarre feedback path that had existed was eliminated. I think that this only happened near half volume because feedback onto the 1S5 grid is zero at zero volume, as the pot shunts the grid to AC ground. At full volume, there won't be as much shunting, but the demodulator circuit would load the 1S5 grid, reducing potential feedback.

At half volume there's minimal damping, allowing the circuit to take off. It's similar to another radio I was working on in the past, which would hum at around half volume; the dressing of the volume pot leads past the rectifier section had allowed hum pickup, and was loudest at half volume when the first audio grid had minimum loading.

With a worst-case impedance from the 1S5's grid to ground of some 300kΩ+ at 1kHz, it wouldn't need much stray capacitance feeding back from V4's anode to V3's grid for the circuit to take off.

Did Astor's KQ suffer a similar problem? Maybe. The KQ added a 50pF capacitor from the volume pot's wiper to ground. It's hard to see what useful effect such a small additional component could have in an audio circuit. But it might be just enough to prevent oscillation.

And maybe that's where the designers of the National AKQ got caught out. Astor's 50pF capacitor was definitely not installed in National's AKQ.

Maybe National were lucky with most sets, and mine is one of a few that suffered from oscillation. Having fixed it, I re-checked the 1S5's voltages. Finding the screen a bit low, I replaced

bypass capacitor #13 and series resistor #16 with new components.

IF alignment

I was able to align the first IF stage transformer primary and secondary without a hitch. But upon attempting to align the second IF stage primary, I ran into a problem.

Driving the slug all the way in failed to produce a peak, while the secondary tuned up just fine.

Winding continuity was OK, so I removed the IF transformer and slipped its can off. A simple resonance test showed that the winding was not tuning up. Replacing the 50pF tuning capacitor remedied the problem and the IF stage tuned just fine.

The set now appeared to be going OK, but why wasn't the AGC working? I didn't need my output meter to tell me the volume was all over the place between local and remote stations.

The 1T4 IF amplifier has a screen resistor, so this is a good place to look for a voltage rise as the AGC takes over and reduces the valve's current. Measuring the voltage across this showed almost no variation with signal strength.

This was similar to the previously-described Aladdin FG set. The culprit in the AKQ was AGC filter capacitor #3, a 50nF paper capacitor which was leaky. Since the AGC signal is supplied via 3MΩ resistor #17, it doesn't need much leakage to shunt the AGC signal to ground. A new polyester cap fixed it. I also replaced IF screen bypass capacitor #2 and some other caps and resistors that looked suspect.

How good is it?

RF performance, taking into account the single-turn antenna, is good. For a 50mW output, it needs around 350μV/m at 600kHz and 400μV/m at 1400kHz for signal-to-noise ratios of 20dB and 25dB respectively.

Input levels at the converter grid, as shown on the diagram, seemed a bit high. This set uses simple (undelayed) AGC where gain reduction applies even on weaker signals. Shorting out the AGC line gave about double the sensitivity for a 50mW output. So it's true that simple AGC does compromise a set's ultimate sensitivity.

Be aware that I used my ferrite rod radiator for these results, and that it was only specified for radiation into another ferrite antenna. If an antenna guru is reading this, maybe they can comment on the validity of my test setup. The results appear to tally with other sets using multi-turn loop antennas, so I'm confident in listing them.

RF bandwidth is around ±1.7kHz at -3dB; at -60dB, it's ±29kHz. AGC action is only fair; a 6dB increase in input signal strength was almost matched by the same rise in the output signal. With a 40dB input rise, though, the output rise was around 20dB.

Audio response is 240~2800Hz from volume control to speaker; from the antenna to the speaker it's 270~2300Hz.

Audio output is only about 120mW at clipping, with 10% THD. At 50mW, THD is around 7.5%; at 10mW, it's about 4.5%. The output is low compared to manufacturer's figures which have the 3S4 giving 180mW with a 67.5V HT. Everything tested out OK, however, and the set is loud enough for its intended use.

The set's performance does depend on the orientation of the antenna strap – my bench measurements required careful orientation to get the sensitivities quoted.

In practice, it's best used with the strap opened out and pointed in line with the direction of the desired station. Loops work best with a difference in magnetic induction from one side to the other, ie, with the loop's plane pointing to the transmitter.

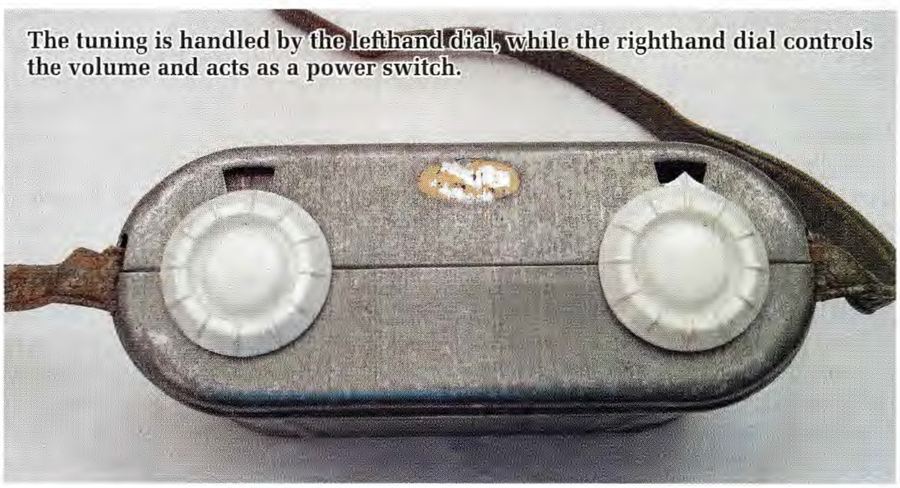
You can just put the strap over your shoulder and face towards (or away from) the station.

The set picked up 3WV Western Victoria at a reasonable volume, a station some distance from me.

I'm happy with the Walkabout as a "town portable". It's an example of Aussie ingenuity that helped make radio programs available to anyone, anywhere, any time.

If you want more information but don't have access to the AORSM, check out the HRSA's Yellow Pages at **hrsa.asn.au** At least one member offers the complete collection on CD, and it's a most valuable resource if you're into old Australian radios.

Thanks to Kevin Chant, Stuart Irwin and Mike Osborne for helping me track down the circuit diagram. **SC**


The tuning is handled by the lefthand dial, while the righthand dial controls the volume and acts as a power switch.