When I Think Back...

by Neville Williams

Vintage radio receiver design — 8: The evolution of table and mantel models

The majority of Australian mains powered receivers in the 1930's were 4/5-valve floor model superhets as already discussed, but the `second set' concept generated a supplementary demand for 3/4-valve `table' and `mantel' models. These shared much the same basic technology, but were subject to quite different design objectives.

Before embarking upon this further dimension of receiver design, it may be appropriate to 'clear the decks' by commenting on an aspect of domestic dual-wave sets, large or small, which had to be held over from the last article. I refer to tuning systems of the day, and the frequent difficulty in locating and/or identifying individual short-wave stations.

In place of the humble 0-100 celluloid vernier dials that characterised console receivers in the early 1930's, the models that followed later in that decade were commonly fitted with comparatively large, edge-lit glass dials that offered a more striking and informative display. Blue/green sailing ships seemed to be the preferred motif, surrounded by an array of local and interstate station callsigns.

As well, multiband sets carried shortwave calibrations in metres and kilocycles, plus the odd overseas transmitting centre: London, Paris, Rome, New York, etc.

Unfortunately, and despite the sometimes pretentious graphics, the shortwave calibrations indicated, at best, where overseas stations would most likely be found — and then only by careful and attentive tuning! Virtually all domestic shortwave receivers suffered from this same limitation, for which there was a compelling technical reason:

To take in the broadcast band, multiband receivers had to be fitted with a standard tuning gang of about 415pF maximum, in order to cover from around 550 to 1600kHz — a ratio of about 3:1, embracing a total bandwidth pf about 1000kHz.

On a typical dial scale, a local AM broadcast band station might spread over 6mm or more, making it relatively easy to identify and to tune for the best sound.

When switched for shortwave coverage, the same tuning gang would still span a ratio of 3:1 (e.g., 13.5 - 40.5 metres), which represented a useful segment of the shortwave spectrum. But this was/is equivalent to 22 - 7.4MHz, embracing a total bandwidth of over 14,000kHz — fourteen times that of the broadcast band.

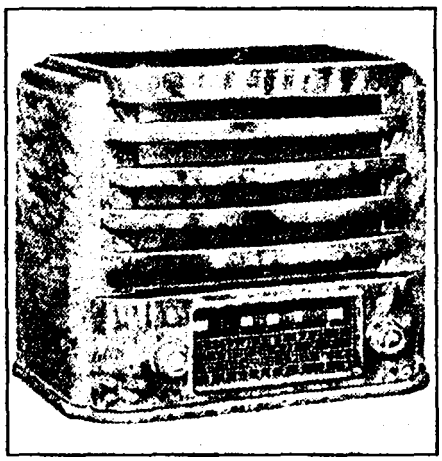

Fig.1: A Kriesler 'compact' D/W receiver, as advertised In our November 1939 issue. In a moulded cabinet, with a choice of five colours, it retailed for around £13 ($26).

Since an AM shortwave station occupies only the same 20kHz-odd of bandwidth as an AM broadcast transmitter, it follows that with such a tuning range it will occupy only about one fourteenth of the dial space — even for a strong signal.

That amounts to only about one-half millimetre, or the thickness of a pointer or calibration mark.

To make matters worse, neither the circuitry nor the mechanics of an ordinary analog (tunable) domestic receiver could/can be held to an accuracy equivalent to the width of a line on a large dial. So a shortwave station of specified frequency will rarely coincide with the dial calibration — and even if one goes searching for a particular signal, it will be less than a millimetre wide, and therefore very easy to overlook.

It helps if the dial mechanism can be made as smooth as possible and free from backlash but, at best, it is difficult to locate and identify shortwave stations relying purely on dial markings. A few models featured double-vernier drive knobs and/or supplementary 'band-spread' pointers, but they could offer only very limited assistance with what remains a fundamental limitation of ordinary tunable domestic multiband receivers.

Now to take up the main theme of this present article:

Smaller, simpler, cheaper?

Scaled-down superhet receivers, using mostly three valves and a rectifier, were an integral part of the world radio scene for so long that, like the proverbial poor, they seemed always to have been with us. However, when I began to reflect on the matter, I realised that such was not the case. They had had a belated marketing timetable in Australia, and a design philosophy all of their own,

With hindsight, it became evident that, when mains-powered 4/5-valve superhets won acceptance in the early 1930's

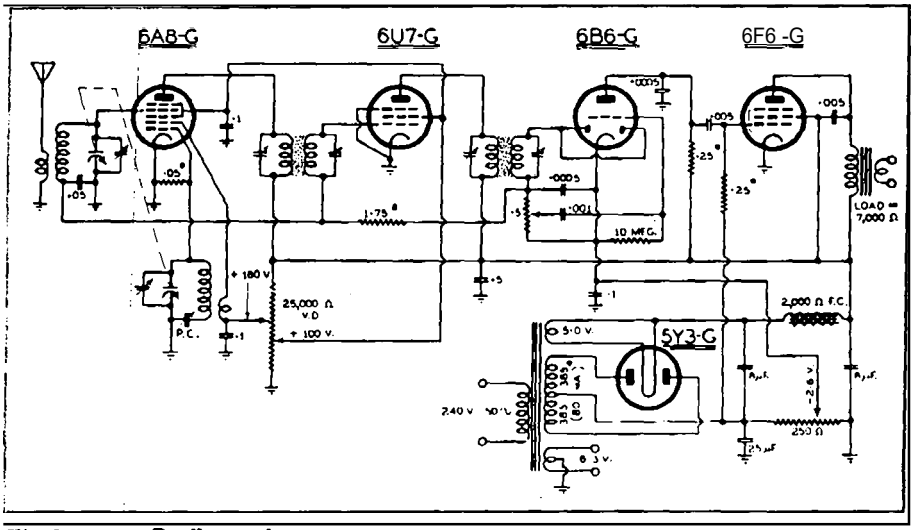

***Fig.2:** From **Radiotronics** 99 (July 1939), this circuit suggests the ultimate In simplicity for a 4/5-valve superhet. To that point in time, **AWV** had not encouraged the Idea of dropping the first audio stage, possibly because they lacked a high-gain output valve.*

as the optimum design for an average Australian home, polished plywood console cabinets were entrenched along with them, free-standing against the living room wall. Perhaps I should add: with or without in-built record playing facilities, which became increasingly popular from the mid 1930's onwards.

To use a modem 'buzz' phrase, such receivers assumed the role of the 'entertainment centre', around which Australian families would gather each evening to enjoy their favourite serial, quiz show or drama. Anything less pretentious than a full-sized cabinet, bedecked with ornament or family photograph, would have lacked credibility!

That compact models had not been totally overlooked, however, is evidenced by a letter from Ray Brown, an old-timer from North Haven, NSW. Ray remembers having constructed what *Wireless Weekly* presented in the early 1930's as the first so-called 'midget' superhet — a 5-valve design (57 autodyne, 58, 57, 2A5 and 80) in a 'boxy' cabinet measuring a mere 11 x 7 x 6 inches (28 x 18 x 15cm).

This was followed by a 3/4-valve version using a 57, 57, 2A5 and 80 combination — the 58 IF amplifier having been omitted, along with one IF transformer. To compensate for the loss of gain, a reaction winding was added to the remaining IF transformer, so that the second 57 could function as a regenerative detector at 465kHz.

A padder-type compression capacitor served as a semi-fixed reaction control. It was an interesting combination of old and new technology, which Ray Brown says worked well. In its *day*, *the* idea of a regenerative superhet, where the reaction could be preset, held a certain fascination for experimenters. But to the best of my knowledge, the circuit found little practical application.

By chance, discussing the same era, a friend from the Blue Mountains area of NSW mentioned that his neighbour had owned an Astor 'Mickey Mouse' receiver. He can't remember much about it, except that the sound level seemed remarkable for the size of the set.

`Table' model sets

Another reader/correspondent, Ted Baker of Bathurst, sent me an historic photostat showing the **'Airmaster'** range of broadcast band receivers as marketed in 1935. At the economy end was a 3/4-valve superhet which was offered in two cabinet styles: a slim and presumably inexpensive free-standing console and a lone, relatively bulky table-top model, which I would estimate to have been about 20 inches (51cm) tall.

I worked at Reliance Radio until about 1936. A small company, it could readily have diversified into pint-sized models, but the management *presumably* felt that the demand for them was limited — or at best patchy.

The only economy model Reliance produced at the time, over and above their normal manufacturer-to-you range, was identified as the 'Series 14-B'. Adapted from their *standard* 'Series 14' 4/5-valve superhet, it used a more compact chassis, admitted to the odd economy measure and assumed the use of a cheaper cabinet. While available as a table-top model, its main appeal, as I recall, was as an economy domestic console — with much the same valve complement and circuitry as the higher priced model.

After leaving Reliance, I worked for about three months in a factory at Redfern, Sydney, producing receivers for the Emmco/NST/Wilkes organisation(s). Again, the output comprised predominantly console models.

Lest I was being mislead by non-typical examples, I checked through my file of ***Radiotronics*** promotional bulletins, issued by the AWV Applications Lab. Their job — and my job when I sub-

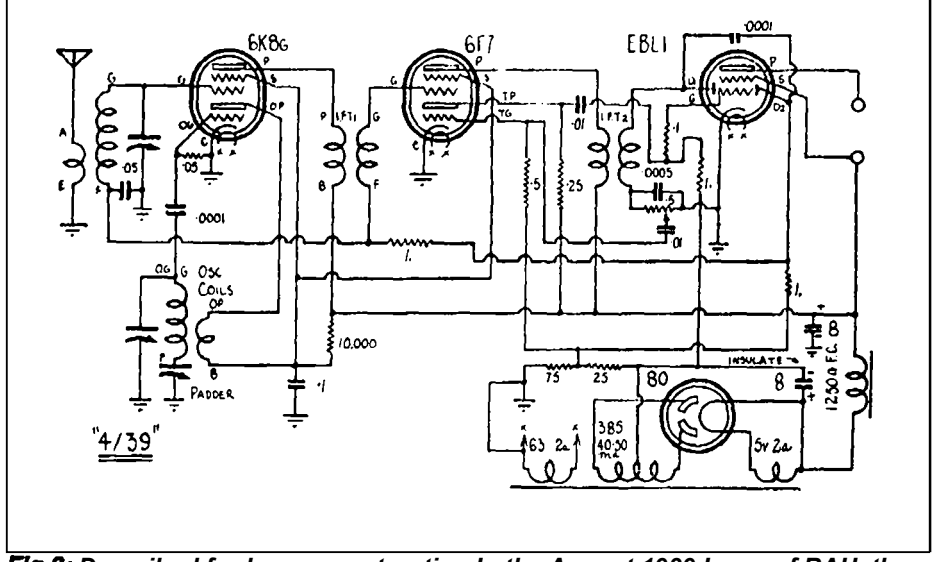

***Fig.3:** Described for home construction In the August 1939 Issue of RAH, the '4/39' was noteworthy because it duplicated the stages of a 4/5-valve superhet using one less valve. It perpetuated the assumption that even small sets should be able to receive interstate and overseas stations.*

sequently joined the AWV team — was to identify designers' priorities Australia-wide, and to complement them with technical information about the Company's inventory.

In my *Radiotronics* file, which covers from late 1935 to October 1941, there were several typical circuits for 4/5-valve superhets, circuits for up-market receivers using an RF stage and/or a more elaborate audio system, and a sequence of fairly ambitious battery powered receivers for country listeners.

But there was title or no mention of physically small receivers or designs with fewer stages. Either the Valve Company Lab team had been remiss, or there was indeed very little local interest in scaled-down domestic receivers.

That they were in production, however, even if in limited numbers, is evidenced by an advertisement in the November 1939 issue of R & *H* for what Kriesler called their 'Dual Wave World Range Compact' receiver. Illustrated in Fig.1, it came in a walnut or black moulded cabinet and retailed in NSW for £1$^{2}/_{1}$9/6 ($26), or slightly more in other states and/or in cream, green or marble.

Only just cheaper!

The one deliberately simplified circuit I encountered in *Radiotronics* is shown in Fig.2. Taken from *Radiotronics 99* (July 1939), it minimises the number of components and uses five economically priced valves.

In practice the cost advantage would not have been great and, as in the case of the Reliance series 14-B, any substantial savings in the end price would have had to come from the cabinet, the dial and loudspeaker.

Because of the special nature of the circuit, however, it may be appropriate to interrupt the main theme of the article to comment on the compromises which were deemed acceptable by the Valve Company engineers for an economy broadcast band receiver.

The usual 100pF oscillator grid coupling capacitor was omitted, the circuit being so configured that the normal tuning capacitors blocked any direct path to earth for the grid current. The performance of the 6A8-G was not adversely affected by the omission.

The use of a back-bias resistor with adjustable tapping allowed three of the four cathodes to be directly earthed, and that of the 6B6-G to be bypassed only with an 0.1uF.

Simple AGC was specified, with a 1.75M isolating resistor to minimise loading on the diode detector. Nowadays, 2.2M would be a logical substitute.

The circuit also exploited the novel idea of operating the 6B6-G (or other similar high-mu triode) with a IOM grid resistor and zero nominal bias. In fact, grid current through the unusually high value resistor (accentuated by rectified IF, noise and audio signal components) would generate sufficient *bias* to allow the high-mu triode to operate normally, presenting a nett input impedance of half that of the 10M resistor. This high figure explains the use of a 0.001uF (1nF) input coupling capacitor.

An 025M grid resistor for the 6F6-G was mandatory by reason of the back-bias, the .005uF (5nF) coupling capacitor being admittedly smaller than optimum. A .02uF (20nF) would be a better choice if the bass response was open to question. The 25uF electrolytic across the back-bias resistor could likewise be omitted, if a slight loss of bass and slight increase in hum could be tolerated.

The circuit was deemed unsuitable for the application of negative feedback around the output stage, but the combination of .0005uF (500pF) capacitors on the grid and anode of the 6B6-G and that of 0.005uF (5nF) on the anode of the 6F6-G was sufficient to suppress the residual IF component and smooth out the treble response for routine listening.

As an exercise in cutting corners, circuit No.RD44, which carries my initials, was out of character for the AWV Lab; but it may provide a handy resource for vintage enthusiasts. It would hold good for 1930's-style equivalent valve types as under:

6A8-G/6A7/2A7;
6U7-G/6K7/6D6/58;
6B6-G/6Q7/75/2A6;
6F6-G/4^/2A5;
5Y3-G/80.

So back to the original theme:

Early *R & H* Issues?

It might be argued that valve manufacturers could scarcely have been expected to promote designs calling for a reduced valve complement. With this in mind, I also thumbed through volume one of this magazine, first published monthly in April 1939 under the title *Radio & Hobbies ('R & H').* It was produced by the experienced *Wireless Weekly* team, who should certainly have been able to identify the dominant interests of prospective readers.

In fact, the initial four issues contained constructional articles on up-market receivers using six or more valves, plus a number of elementary battery sets for beginners. It was not until issue five (August 1939) that they got around to a `midget' mains operated receiver for everyday use: the dual-wave '4139', described by (the late) John Moyle.

To my mind, that receiver and the designs which followed over the next 20-odd years epitomised the thinking behind a succession of valve-based Australian 'mantel' radios, as distinct from the earlier and more bulky 'table' models — or scaled-down consoles.

In his introductory remarks about the '4/39', John Moyle explained that 'baby' receivers were already very popular overseas. Some were even mass produced, at prices so low that it was

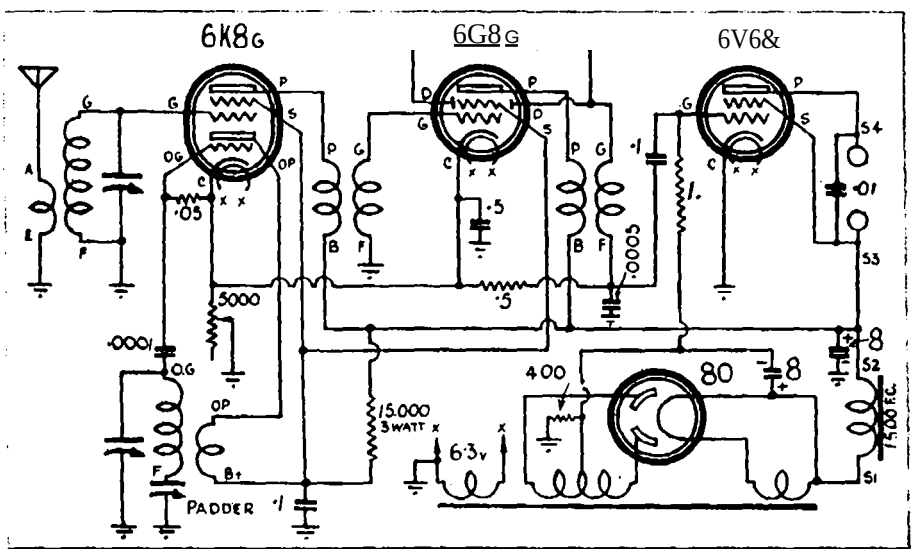

Fig.4: The original 'Little General' circuit from the April 1940 issue of R&H. Thousands of them were built by readers. To assist experimenters, options like fitting a dual-wave bracket ora loop antenna were detailed In subsequent issues.

cheaper to replace them when they failed, than to have them repaired.

By contrast, John said, while local demand for small receivers was rising, Australian listeners had become conditioned to conventional receivers in large cabinets — so much so that most would find it both 'amusing and interesting to hear music and speech coming from a small box only a few inches either way'.

Wireless Weekly, he said, had featured the '4/38' mantel receiver during the previous year, reducing the usual 4/5-valve complement by omitting the voltage amplifier and driving the output pentode directly from the detector. As some local manufacturers had found, the resulting gain was sufficient for day-to-day broadcast reception but insufficient for use on the shortwaves. This time around, ***R &H*** wanted to do better than that.

In a quest for higher gain, the editorial team had considered resorting to a reflexed IF/audio stage, but were deterred by the difficulties that others had encountered with the idea. (Reflexing was discussed on pages 38-39 of our June 1991 issue).

A little 'big' set!

As it turned out, the ***R & H*** team came up with an ambitious 3/4-valve circuit, as shown in Fig.3, which provided the same sequence of stages as a normal 4/5-valve superhet. In short, it met what they saw, at the time, as a minimum requirement for any Australian family receiver — be it large or small. The circuit is interesting in its own right.

A 6K8-G served as the frequency changer, with a common feed resistor for the screen and oscillator anode — a configuration which (in the case of the 6K8) was said to counteract the effect of supply voltage variations, minimising oscillator frequency shift and the associated risk of 'motorboating'. Shortwave coverage could be provided by replacing the single coils shown in the circuit with a readily available dual-wave coil bracket.

From the frequency changer, the signal passed to a 6F7, an imported American double valve containing a triode and a variable-mu pentode section, independent except for a common cathode. With pentode characteristics very like those of a 6B7S/6G8-G, the 6F7 could serve as a normal IF amplifier stage, with AGC control.

After IF amplification, the signal passed to twin diodes in a European duodiode output pentode — a valve with about twice the transconductance -- and therefore power gain — of the 6V6. Its intended role was for use in 3/4-valve superhets, operating directly from the detector output.

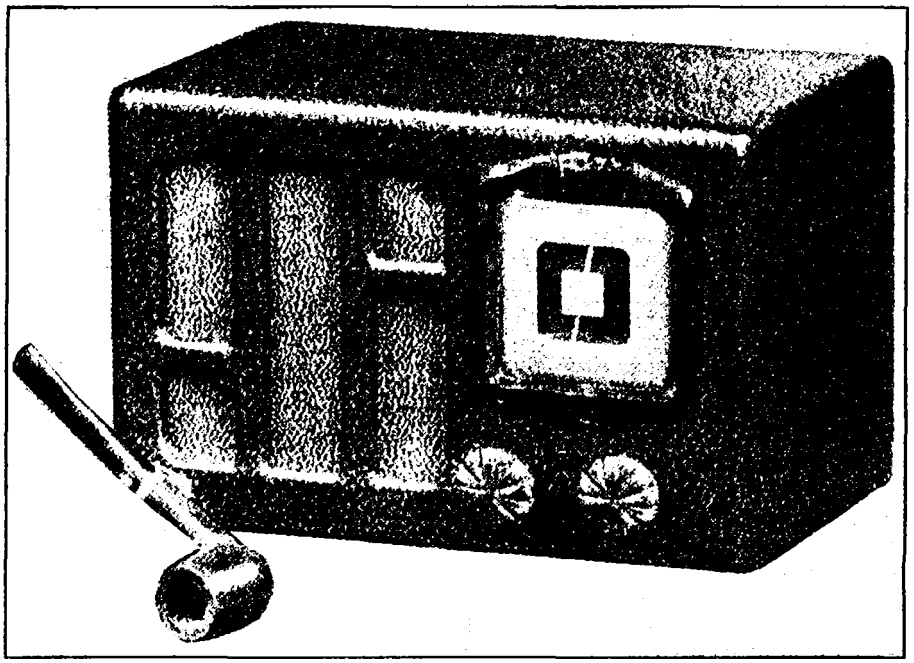

Fig.5: The original 'Little General; in its inexpensive leatherette covered cabinet. The one-piece escutcheon and dial scale pushed In from the front, the 'pointer' being a white line on a drive drum fixed to the shaft of the tuning gang.

In the 4/39, however, the signal was passed back through the 6F7 triode section for prior amplification. With an amplication factor of 8, similar to that of the early type 27 triode, the stage gain was quite low. However, when feeding an EBL1, and in the absence of negative feedback, the overall audio gain would not have seemed all that different to the user from a conventional 4/5-valve superhet.

An interesting aspect of the circuit was that it used back-bias for all stages, including the AGC system. Without going into details, this allowed all cathodes to be grounded, thereby avoiding the complications which might have arisen in providing self-bias for the multi-purpose cathodes in the 6F7 and EBL1. The bias levels were set to keep the current drain within the capabilities of the specified 40mA power transformer.

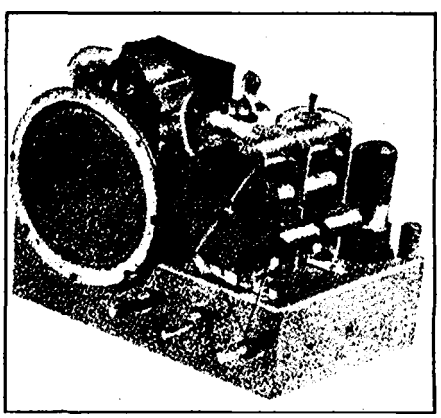

Fig.6: The completed chassis of the 1946 little General. It differed from the original mainly by the inclusion of one of the options, the fitting of a dual-wave bracket, accounting for the extra {central) control shaft.

Superlatives were not spared in describing the appeal and performance of the 4/39: at lOW x 7D x 811 inches (25 x 18 x 20cm), it was 'small enough to take with you on holidays'.

Again: 'on the broadcast band there appears to be nothing that it cannot tune in'. And: 'if there is anything on the shortwave bands worth listening to, you will hear it at excellent strength'.

'A new star arrives'

Despite the apparent enthusiasm, less than a year had passed (April 1940) before John Moyle was waxing equally eloquent about a new midget receiver which the ***R & H*** staff had developed in the meantime.

It would appear that a few month's experience with 4/39 had confirmed the appeal of a receiver that could be carried at will into the kitchen, the sewing room, the workshop or the kids' bedroom for music, news, race results or whatever. But what had also become abundantly clear was that the set was rarely if ever tuned to interstate or overseas stations. For the role of a personal or 'second' set, the 4/39 had clearly been over-designed.

So the emphasis in the new receiver (Fig.4) was on portability, simplicity and

low cost. Gone was the dual-wave bracket and AGC, the 6F7 and the EBL1, to be replaced by ordinary coils, a 6K8-G frequency changer, a conventional 6G8-G IF amplifier and diode detector, and a 6V6-G biased to limit the total drain to 40mA.

Under the banner 'A new star arrives', the simplified design was presented as the 'The Little General Mantel Receiver' — a title that someone has suggested was intended to catch the eye of hobbyists in uniform.

Yes, said John Moyle, the Little General will still receive the main interstate stations at listenable volume, but its main role is to provide intimate personal listening to the local stations — without a hint of the audio noise and hum that can all too easily be audible in small receivers used close-up at low volume.

Fig.5 shows the prototype, photographed for size comparison with John Moyle's perennial pipe. The cabinet was produced at low cost by numerous cabinet makers, but it was well within the capabilities of a handyman.

Assembled from off-cuts of plywood, composition board or softwood, the basic box was first sanded smooth, with rounded corners. After a generous coating of carpenter's glue, it was overlaid with figured 'leatherette', with a scrap of decorative cloth backing the loudspeaker grille.

Phenomenal response

The Little General certainly 'hit the spot' with *R & H* readers. Backnumbers of the April 1940 issue were rapidly exhausted and, thereafter, a constant stream of requests for copies of the circuit arrived through the *R & H* 'Shilling Query Service'.

Before wartime restrictions put a brake on the marketing of new components, it was evident that *the* sale of key items by the various suppliers had run into five figures. How many of them were absorbed by 'backyard' factories we will never know.

Even without firm statistics, it is difficult to escape the conclusion that the *R & H* 1940 'Little General' played a major role in focusing the attention of the industry and listeners alike on mantel model receivers for personal listening. Even during the war years, the Little General's very simplicity made it an obvious choice for anyone who wanted to 'knock up a set' from oddments.

During this same period, follow-up articles suggested ways in which experimenters could increase the gain (April 1940), or provide a loop antenna (June 1941), or fit a dual-wave bracket into the original chassis (December 1941).

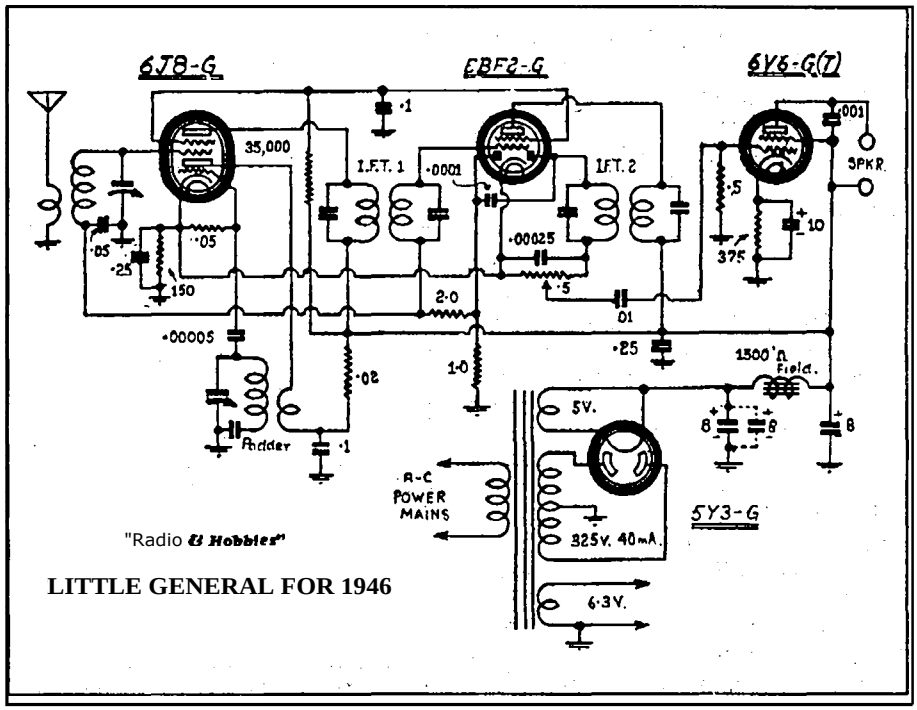

Fig.7: The circuit of the 1946 'Little General, which suggested using the new 6JB-G converter, reverted to automatic gain control and encouraged the use of a lower voltage power transformer.

I recall also that someone discovered that a quite healthy sound could be obtained by feeding the signal from a high output standard groove crystal pickup to the grid of the output pentode.

Besides seeing a few Little Generals end up as mini-radiograms, the idea also gave birth to a one-valve phono player — which was novel, to say the least.

Post-war Little General

In January 1946, as Technical Editor, I made my own contribution to the Little General saga with an update of the earlier articles — which had long since gone out

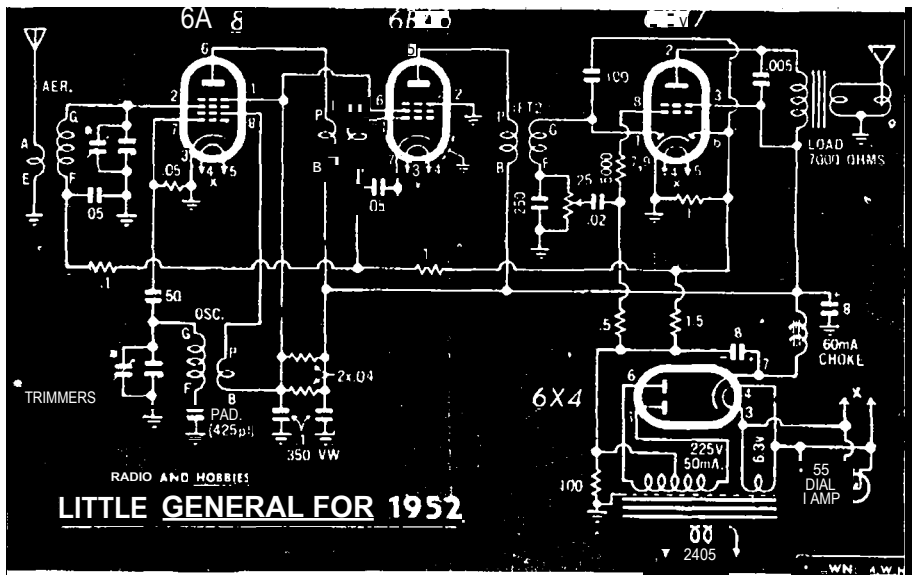

Fig.8: Breaking with tradition, the 1952 tittle General' specified the use of all-glass miniature valves and matching miniature coils and IF transformers. It also saw the adoption of a permag. dynamic loudspeaker and a more energy efficient power supply — all typical of contemporary commercial mantel receivers.

of print. (In those days, office photostat copiers were still 30-odd years down the track).

I explained in the preamble that, while smaller valves and components were on the horizon, the most realistic course as at January 1946 was to retain the chassis, layout and cabinet of the original Little General, adapting the circuit and parts list to accommodate the components most likely to be accessable in this immediate postwar period.

Fig.6 shows the completed chassis, which looked essentially similar to the original version. The dial kit, probably from RCS Radio, involved a moulded drum, which attached to the gang shaft, a knob spindle with a tight-fitting rubber grommet and a length of woven drive cord with tension spring. The matching escutcheon and dial scale fitted through a cutout in the front of the leatherette covered Cabinet.

The recommended circuit (Fig.7) showed a 6J8-G as the preferred frequency changer, but other valves such as the 6K8-G, 6A8-G or 6A7, which might be on hand, were suggested as legitimate alternatives.

Following the convention of the magazine at the time, the circuit showed only a single set of coils, and in fact constructors pad the option of installing a set of broadcast coils underneath the chassis.

However, the presence of three controls confirms that the prototype carried a dual-wave bracket instead, on the basis that it involved so little extra effort and outlay that we had decided to do it that way, that time around.

An octal-based EBF2-G was nominated as the preferred IF amplifier/detector although, again, there were other options in the way of the P-based version, or the 6G8-G or 6B7S.

My choice at the time was to revert to the use of AGC rather than manual gain control, the detector and delayed AGC circuitry being exactly as might be found in the front end of a full-size 4/5-valve superhet. Output from the detector was fed directly to a 6V6-G or 6V6-GT — valves that by then were so plentiful that alternatives were not even discussed.

In the power supply, a point of note was that a definite effort was being made to discourage the use of a traditional 385/0/385V secondary and to promote a 325/0/325V rating for small receivers, to avoid needlessly high voltages and heat dissipation.

After several years of wartime shortages and uncertainties, the article was very obviously intended to re-position the 'Little General' as an important and on-going feature in the *R & H* repertoire of do-it-yourself projects. To borrow John Moyle's phrase, it was a clear indication that Australians were becoming accustomed to hearing music and speech coming from a small box!

According to *EA*'s old valve receiver master index, which Jim Rowe kindly looked up for me, the Little General popped up again in August 1947 and July 1951, with a totally new version presented by Raymond Howe in September 1952.

`Modern' valves

Climaxing the trend set in the previous year, the 1952 version (Fig.8) discarded once and for all the option of using conventionally based valves and specified a new chassis to accommodate only the new all-glass miniature valves, along with proportionately smaller coils and IF transformers.

Using the same size chassis and cabinet as previously, there was room above the chassis for all the major components and also for a modem edge-lit glass dial, leaving ample space underneath for uncluttered wiring. Noteworthy also was the use of a dynamic loudspeaker with a permanent magnet rather than an electromagnetic field coil — a spin-off from wartime technology.

Despite their much reduced dimensions, the new miniature valves were well ahead of the older types in terms of gain and efficiency. The 6AE8 triode-hexode converter had about twice the conversion gain of the older types, the 6BA6 offered two to three times the transconductance of earlier IF amplifiers, while the 6BV7 was way ahead of the 6V6-G and even more sensitive than the EBL1 — once the pride and joy of the Philips/Mullard range.

With overall back-bias and delayed AGC, the 1952 circuit invites obvious comparison with those discussed earlier. But allowing for a gain advantage of around 2:1 per stage, the overall sensitivity could be expected to be well up on the earlier 3-stage versions. A further point of note is that, with the use of a relatively low-resistance choke in place of the loudspeaker field coil, HT voltage drop in the filter system was less.

In addition, the indirectly heated 6X4 miniature rectifier was much more efficient than the old 5Y3/80, offering the further advantage that it did not call for a separate 5-volt filament winding. It permitted the use of a simpler power transformer delivering much lower voltage, but with a higher current rating.

Since all of the valves shown were Australian-made, along with virtually all the other components, the Little General for 1952 had a lot in common with postwar mantel receivers offered by Australian manufacturers. Some even used leatherette-covered cabinets; but in line with overseas trends, those who could cope with the initial expense *came* up with a variety of moulded plastic designs.

Occasionally, much to the delight of home constructors, production over-runs of such mouldings turned up later in surplus clearance dealers, giving enthusiasts the chance to accommodate their handiwork in a decidedly 'non-handyman' cabinet.

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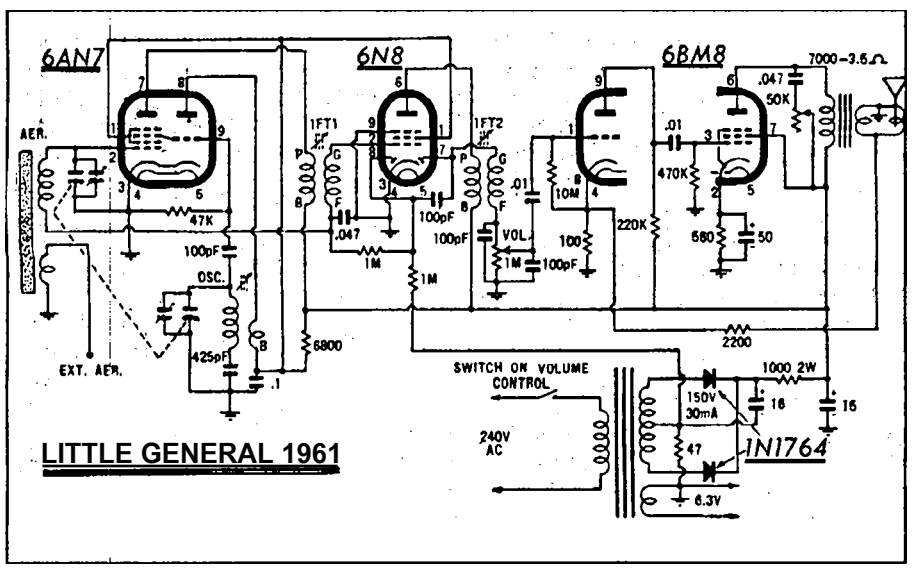

Fig.9: The last of the tittle General' series, using what was virtually the last generation of mass produced valves. This series also featured widely in Australian monochrome television receivers, before giving place to solid-state devices:

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The final chapter

A detailed sequence of articles in the issues June-September described the construction of the 1956 version, with the 1957 version appearing in April of that year. By that time, the situation had changed. TV broadcasting had commenced in Australia, and it was obvious that radio would no longer dominate family entertainment. ATV set would in future take the place that had been occupied for so long by the radio console. ,

· For sure, radio would still have a place for casual listening — provided the set didn't take up too much room and could be moved around, as required. Quite suddenly, from being a second set, the 'Little General' type of radio had become the only one that most families needed.

The final chapter in the 'Little General' saga came in a series of articles by Alan Nutt (March-June 1961), culminating in the design shown in Fig.9. Ironically, it reverted to the basic design which had set the ball rolling in 1939: a four-stage circuit using three valves — this time Philips all-glass 9-pin miniatures, manufactured in Australia and equally popular with commercial manufacturers.

A 6AN7 triode-hexode converter was fed from a ferrite-rod loopstick, in lieu of an antenna and antenna coil. This was followed by a 6N8 duo-diode pentode, doing the job of a 6G8-G/6B7S, but much more efficiently. Last but not least, the 6BM8 provided a high-gain triode audio stage and a high-gain output pentode, expressly intended for that role.

The valve rectifier had disappeared, to be replaced by a pair of semiconductor power diodes — the first step to what was soon to follow, with all valves being replaced by solid-state devices.

In the meantime, what happened to the negative feedback, which was featured in the later 4/5-valve and larger receivers? In brief, negative feedback was/is fine if: (1) There is gain to spare; (2) The circuit is amenable to its use; and (3) The loudspeaker and baffle system is of sufficient quality to justify it. Faced with these prerequisites, most small-set designers said: 'Forget id'

Within a few years, anyway, Australian valve/mantel sets would *be rendered* obsolete by imported transistor portables featuring optional mains/battery operation and multiband reception — not in response to Australian demands, but because they were universal designs intended for world markets! ❖