



When I Think Back...

by Neville Williams

Vintage Radio Receiver Design 1 The 1920's: a decade of 'give-it-a-go'!

Looking back over the years, vintage radio enthusiasts may well gain the impression that receiver design has been subjected to a bewildering sequence of technical fads and fashions. Perhaps it has but, as this and succeeding articles will show, there have been sober, practical reasons for most of the on-going mutations in components and circuit techniques.

During the '20s, which witnessed the inauguration of public radio broadcasting in Australia, the physical and electrical design of receivers underwent especially rapid and radical deviations — and of little wonder. Within that single decade, wireless broadcasting progressed from pure speculation in the media to an established service, subject to urgent, outspoken demands by the first ever generation of listeners.

Temperamental equipment that could be coaxed to perform for enthusiastic novices might have been tolerated in the early '20s but, by 1930, listeners were demanding receivers and programs that were routinely accessible to every member of the household — not just to the technically inclined.

In urban areas, they reasoned, receivers should logically operate from the power mains and be switched on and off as casually as any other electrical appliance. In the country, listeners had developed their own high expectations — reliable service and upgraded receivers, consistent with manageable battery drain.

Within that same time scale, commercial wireless suppliers had to come up with totally new products to satisfy a totally new domestic entertainment market, with no precedent beyond the humble mechanical phonograph. The guidelines for domestic wireless sets had largely to be worked out by trial and error, 'on the run'!

Not surprisingly, progress in the design of wireless/radio receivers, in the '20s, didn't follow any uniform timetable. While the demands for im-

proved technology and styling were on-going, some suppliers took longer than others to react — as evidenced by articles and advertisements in the wireless press of the era.

By way of example, I would refer readers to that most *informative EA* reprint *The Best of Australia's Wireless Weekly — 1927*, available from most newsagents for about \$4.

All shapes, sizes

In that reprint, conservative crystal, regenerative and reflex receivers appear cheek-by-jowl with superheterodynes and neutrodyne. Models with old-time bakelite panels and multiple tuning knobs contrast with trendy single-dial designs. Table models compete with futuristic self-contained consoles and, in a predominantly battery set environment, Colville Moore offer a lone 8-valve 'all-electric' model. All this, extracted from a few weekly issues from a single year.

Behind such product diversity was the fact that receivers on the Australian market in the '20s were a near-random mix of British, European and American imports, plus local designs assembled by everyone from purposeful manufacturers to 'back-yarders' and hobbyists. Suppliers all tended to 'do their own thing' for as long as they could attract sufficient customers.

In this situation, with mostly limited and scattered sales of any one model, documentation in the way of type designation, specifications and circuit details came a bad last. Nowadays, as a result, information about receivers from the

'20s usually has to be picked up in any way it can — a fact well known to vintage receiver enthusiasts.

The situation changed abruptly in the early '30s when a new tariff barrier favouring locally-made components and equipment set the scene for large-scale production and promotion of uniquely Australian receivers, along with circuit diagrams and/or service manuals from specialist publishers.

Indigenous industry

This, as it happened, coincided with the emergence of much improved technology for AC mains-powered receivers and with a drive by the electricity supply authorities to extend the mains into rural areas. That, along with progressively expanding broadcast services, triggered a huge demand for the new-look models, effectively ushering in the so-called 'golden age' of Australian radio — cut short only by the intervention of television in 1957.

Responding to engineering guidance from suppliers of local valves and other components, designers of the new Australian receivers tended to adopt a more uniform response to market needs so that, behind the differing cosmetic exteriors, circuit practice from the '30s onwards evolved on a much more structured basis than had previously been the case.

It is appropriate to observe here that the rush by Australian listeners to equip or re-equip in the early '30s largely wiped out the motley array of receivers from the preceding decade. Of little practical or sentimental value at the

time, they were either dumped in **toto** or dismantled by experimenters seeking re-useable components.

Or, again, dealers accepted them as 'trade-ins' for a suitably tempting figure, dumping them thereafter by the proverbial truckload.

At the original Reliance Radio **factory/showroom** in York St, Sydney — my first ever job — I remember a stack of old-time battery and semi-electric sets in the musty basement, which ultimately met just such a fate. They cost less to dump than to service and re-sell!

Later, during a brief stint at the **E.F. Wilkes** factory in Redfern, Sydney — my second job — I was confronted by a pile of one-time 'up market' American made **Gulbransen** receivers. Boasting type 50 output valves and the chunkiest dynamic loudspeaker I had ever seen, they were so cumbersome that the staff couldn't even be induced to carry them away gratis!

Now quite rare

In short, with virtually no resale value, comparatively little of that early gear survived intact, with the result that genuine examples of '20s technology are now few and far between. Most of those that do remain are in town museums across the country, in the hands of private collectors, or in antique shops at prices mostly well above what they originally commanded.

One vendor I came across recently was offering a 6-valve AWA receiver 'circa 1925' in ostensibly pristine condition. It carried a price tag — hopefully or otherwise — of \$525.

(Perhaps I should mention here that an enthusiast group dedicated to old-time radio and allied interests is the Historical Radio Society of Australia. Our immediate contact in Sydney is Mr Garfield Wells, NSW State Secretary, PO Box 428, North Sydney 2059).

But I have got ahead of myself. Interwoven in time as they certainly were, it may nevertheless be helpful to take a brief look at major technical trends in the '20s, as a broad background to a more detailed examination of indigenous Australian receiver design in the following decade.

Amateurs, experimenters

In the pm-broadcasting era, most receivers held by members of the public were of simple design, often home **constructed**: 'catwhisker' crystal sets, or 1-, 2- and 3-valve 'reaction' sets — most commonly a regenerative detector followed by one or two audio stages.

Operated by enthusiastic 'experi-

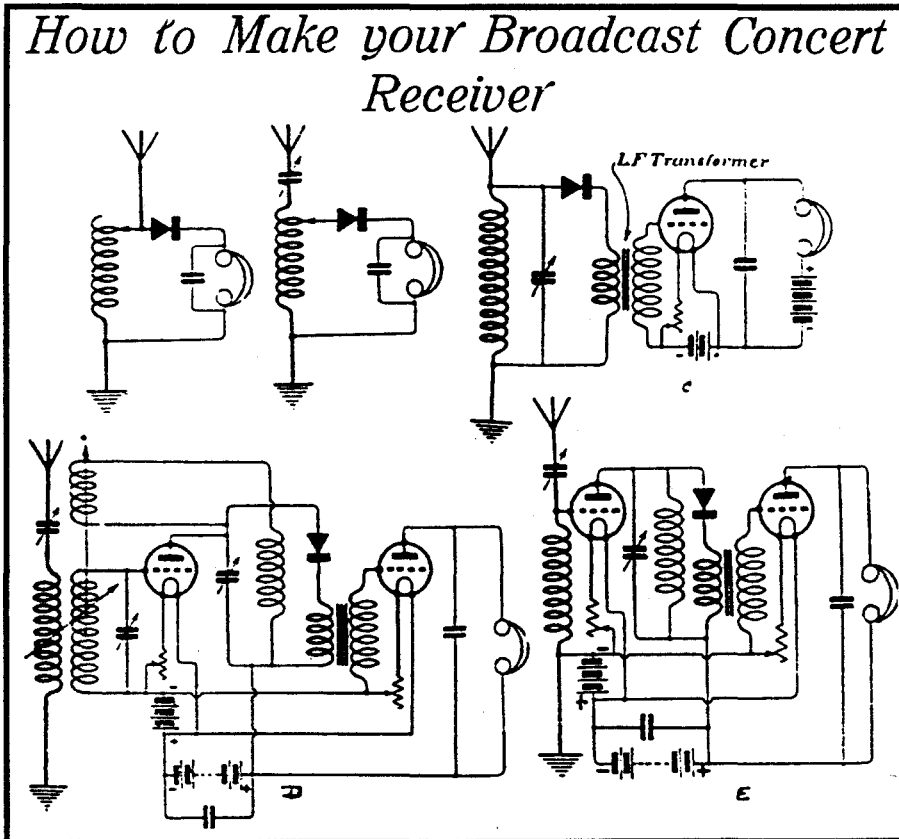


Fig.1: Circuits for 'sealed' receivers for Sydney's pioneer high-power station 2FC, as suggested in the October 1923 Issue of The Australasian Wireless Review. Circuit 'D' uses a regenerative RF amplifier ahead of a crystal detector, followed by one audio stage.

menters', they were used to monitor coastal wireless 'traffic', Morse code, speech and music transmissions from amateur radio stations, and the occasional demonstration concert — in short, whatever transmissions the owner might happen upon by interchanging coils and twiddling knobs.

(A sound documentary of this era is available on the audio cassette 'Loud speakers', from the ABC radio series *Bright Sparks*. It is available for \$15, or \$45 for the complete 8-session series, from ABC Radio Tapes, GPO Box 9994, GPO Sydney 2001. For phone inquiries or credit card orders, ring (02) 339 1034.)

That some professional valve-based receivers were available at the time is evident from the memoirs of Sydney Newman (*EA*, January '91, p.46) where he mentions a batch of Marconi 'Seven' long-wave receivers imported by AWA, around 1921. While appropriate for official communication services, however, they would have been beyond the means of most amateur enthusiasts.

Doubtless anticipating the commencement of formal public broadcasting by the end of 1923, Electricity House in George St, Sydney, advertised a range of

typical components and basic receivers in *Wireless Weekly* for March 9 of that year. Their crystal sets ranged in price from £3/10/0 to £7/10/0 (\$7 — \$15) with one- to three-valve sets priced from £9/0/0 to £35/0/0 (\$18 — \$70).

In practice, the crystal sets would have been of little use more than a few miles from a transmitter, being therefore limited mainly to urban areas.

Under favourable reception conditions, small regenerative valve sets could pick up transmitting stations hundreds of miles away — provided they were used with an efficient outdoor aerial and earth and were critically adjusted, with the detector on the threshold of oscillation.

In the longer term, small regenerative receivers won only limited acceptance by would-be listeners to public broadcasting stations. The reason was simple enough: as distinct from 'experimenters', broadcast listeners were less inclined to persist with weak signals and more likely to expect loudspeaker reception, to be shared by the whole family. In terms of circuitry, this translated into at least a 4-valve receiver, typically comprising a tuned RF amplifier stage ahead of a regenerative receiver, and followed

WHEN I THINK BACK

by two audio stages. But more about that later.

'Sealed set' fiasco

As it happened, the Federal Parliament caused a major 'hiccup' in receiver design concepts in August, 1923 by deciding that the proposed public broadcast stations in Australia should be supported by direct subscription. The idea was that listeners would nominate their preferred licenced broadcaster, pay the specified fee direct to the particular company and instal a receiver capable of receiving that station only.

Said to be the brainchild of AWA's manager Ernest Fisk, the sealed-set legislation cut right across the prevailing concept of sensitive, broadly tuneable receivers, with legitimate access to all available transmissions.

In a rare example of sealed-set mentality, *The Australasian Wireless Review* featured a story on '2FC The First Big Broadcasting Station in Australia' in its September, 1923 issue. The annual subscription fee for the new Farmer & Co (Sydney) station was to be 3 guineas (n.3.0).

Transmitting on 1100 metres (272kHz), its powerful 5000-watt signal would hopefully dwarf existing amateur transmitters and would not call for anything like the same order of receiver gain or selectivity. By implication, the owner of a sealed set would not want to, nor need to, nor be eligible to tune into other less pretentious stations.

In the next monthly issue, with the opening of 2FC only weeks away, the magazine published a group of suggested circuits for 'suitable receivers' (Fig.1) — the only ones I have ever seen intended specifically for Australian sealed receivers.

Unpretentious crystal sets or amplified crystal sets, the magazine suggested that they should be constructed around a coil/capacitor combination which could be pm-adjusted to limit the coverage to within +/-10% of the allotted wavelength, (I quote) 'allowable under the regulations'.

Presumably, the completed receiver had to be set up in such a way that, to the satisfaction of itinerant radio inspectors, the available tuning range would be no greater than necessary to cope with the combined frequency drift of the receiver and the designated station. This was before the routine use of crystal-locked transmitters.

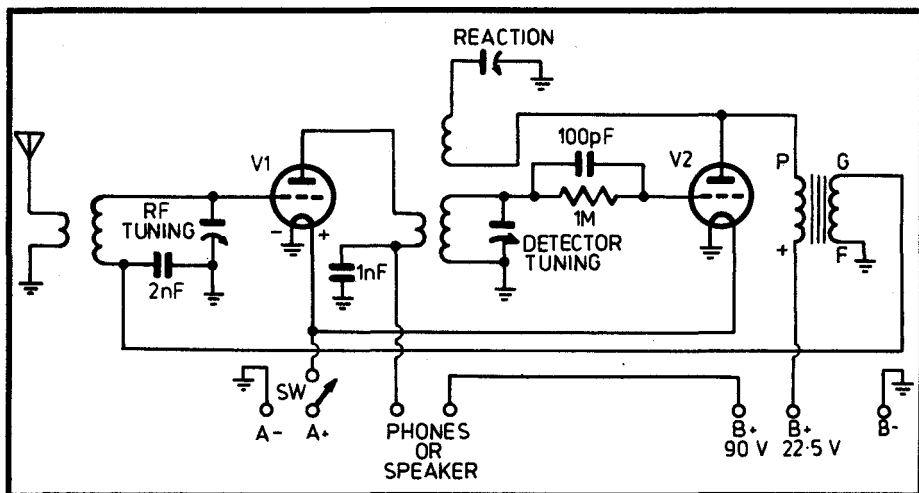


Fig.2: In this simple reflex circuit, the incoming signal is amplified by V1 before being passed on to the regenerative detector V2. The detected audio passes through the transformer back to the grid of V1, where it is again amplified before being applied to the phones or speaker.

Rejected *en masse* by prospective listeners and a potential financial disaster, the sealed set concept lasted less than a year. As from July 17, 1924, public broadcasters like 2FC were re-licensed either as A-class stations, financed by a collective licence fee payable to the Government, or as B-class stations supported by advertising revenue.

From that date, having taken out an annual, comprehensive 'wireless licence', listeners were once again free to use general-coverage receivers, listening to whatever signals came their way.

As before, the more elaborate the receiver, the more stations they were likely to hear, hopefully on a loudspeaker.

Speaking personally, I have never encountered an identifiable sealed set and I can only assume that most of those which were sold during the 6-odd month currency of the scheme were smartly updated for general coverage of the medium- and/or long-wave broadcast bands.

Early broadcast sets

Typical of the early, small general-coverage broadcast receivers was a Colmovox 3-valve 'Junior' model, marketed both as a do-it-yourself kit or built up, by Colville-Moore Wireless Supplies Ltd, of Rowe St, Sydney. It comprised a regenerative detector using panel mounted plug-in coils, followed by two audio stages.

As advertised in *Wireless Weekly* for August 13, 1926, the cost of the basic kit, with a polished maple cabinet, pre-assembled and engraved bakelite panel, and wiring diagram was £6/5/-. Valves, plug-in coils, batteries, headphones and

other 'extras' necessary to make it go added up to another £5/6/10.

In today's currency, just under \$24, that doesn't sound like a lot of money. But at the time, it would have represented a typical month's wages, or as much as we'd now pay for a large colour television receiver! Such prices provided a powerful incentive to cut costs by any available means.

Reflex principle

In an effort to secure a more comprehensive receiver for reduced outlay, some designers resorted to the so-called *reflex principle*. It involved using one of the valves for two distinct functions, thereby saving a valve and its attendant current drain.

For example, in a simple non-reflexed vintage receiver, the incoming signal might be fed via a tuned aerial coil to the grid of a triode RF amplifier stage. From the anode, after amplification, it would pass through a tuned RF coil to a detector and thence through an audio transformer to a single audio stage — a configuration sufficient for reception of distant stations on headphones, or possibly strong locals on a loudspeaker.

In a reflexed version of the above (Fig.2) the 'grid' connection of the audio transformer would typically be wired back to the bottom of the aerial coil, the junction being bypassed to earth with a capacitor of around 2nF — sufficient to allow the tuning circuit to behave normally, but not so large as to prevent the much lower frequency audio signal from reaching the grid.

In short, the audio signal would be fed up through the tuning coil to the RF amplifier grid so that this would be sub-

ject to two quite distinct input signals, one superimposed on the other.

As a result, there would be two different signal components in the plate current — one at the original signal frequency feeding the detector, the other at the superimposed audio frequency. By inserting a pair of headphones between the primary of the RF coil and B-plus, the audio component would be heard as before, having been separately amplified as it passed through the reflexed valve.

Ostensibly, the receiver would equivalent to the original three-valve design (RF amplifier — detector — AF amplifier) but using only two valves — one doing two jobs. In all fairness, however, this last statement needs to be qualified.

The actual saving in a typical reflexed receiver was limited mainly to a valve and socket and the attendant current drain; the other peripheral components and wiring were still required. Besides that, reflexed receivers generally have tended to be somewhat temperamental for the following reasons:

- Having to handle two signals at once, reflexed stages could be more subject to overload on strong signals, leading to increased distortion in some situations.
- By reason of inherent non-linearity, an RF amplifier stage may partially rectify an incoming RF signal and generate a residual detected resultant across the audio load in its anode circuit. This may interact unfavourably with the formally detected signal which it is supposed also to be amplifying.
- The deliberate re-routing of signal back through a receiver circuit could aggravate stability problems arising from other sources — e.g.,

inherent RF stage instability, detector regeneration and HT supply feedback.

While the above-mentioned considerations have limited the appeal of the reflex principle, the fact is that reflex receivers have featured from time to time in do-it-yourself articles and in the inventory of receiver manufacturers. Collectors of vintage receivers can at least be forewarned if they come across one in which a single valve appears to be doing two jobs.

(The 'Vintage Radio' feature in the December, 1990 issue of *EA* deals with a mid-'30s model AWA **Radiolette** using an IF amplifier reflexed to function also as an audio stage. Because of detection effects in the stage, as noted above, the audio volume control could not completely silence the receiver — a well known flaw in this particular configuration).

Typical family set

Price and running costs notwithstanding, the **Colmovox** 4-valve receiver mentioned in the March, 1989 instalment of this series, was more typical of the average family receiver of the mid '20s. (See Fig.3). While physically similar to the 'Junior' model mentioned earlier, it included a separate tuned RF stage ahead of the detector, to ensure improved range and selectivity, and to minimise the risk of detector radiation.

Tuning involved separate dials for the RF and detector stages but, by careful selection and/or trimming of the plug-in coils, the dials could be made to 'track' reasonably well, each needing to be set to about the same reading for particular stations. With two audio stages, the set could be used with a loudspeaker or, for personal listening, with headphones and

with the audio section partially disabled to conserve battery life.

A comparable 4-valve set advertised in *Wireless Weekly* for August 13, 1926 was the '**Selectrodyne**', from the Radio-W'less Mfg. Co, of 317 George St, Sydney (Fig.4). Depending on the cabinet and extras, it cost between £26/10/0 and £36/10/0. Arguably, perhaps, it was advertised at the time as 'the only 4-valve set that will bring in 3L0 (Melbourne, 800kHz) without interference from 2BL (Sydney, 855kHz)' — already much less than the 10% separation envisaged in the sealed set era.

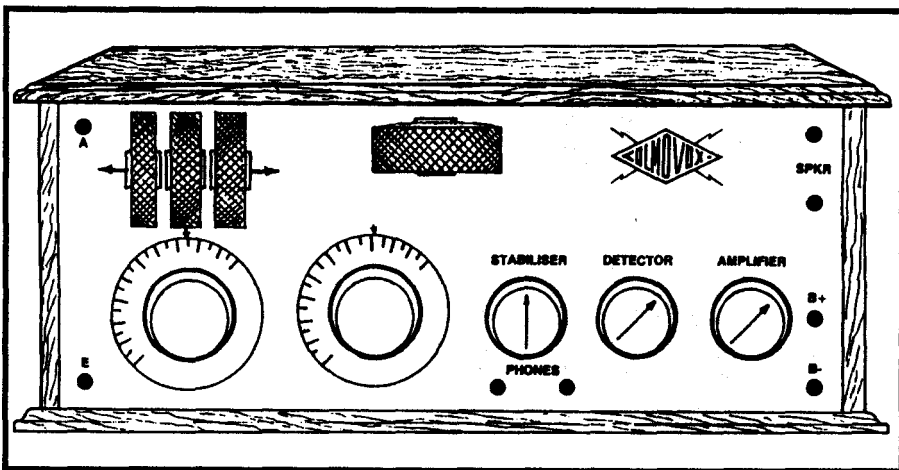
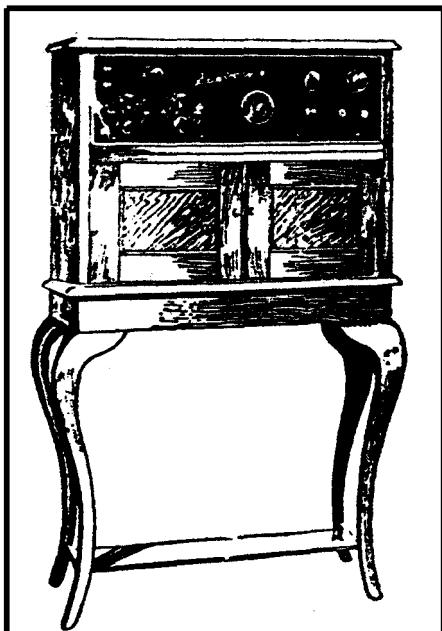


Fig.3: The panel layout of a typical 4-valve battery wireless set from the mid '20s. It represented a manageable compromise for many listeners between inter-station performance and purchase/running costs.



The Selectrodyne

is the only 4-valve set that will bring in 3L0 without interference from 2BL. Constructed in Sydney from all Australian material. Complete £26/10/- to £36/10/-

Take one home to-night
Deposit, £21/17/6; Weekly, 8/9

Radio-W'less Mfg. Co.
317 George Street, Sydney
B 5747

Fig.4: The Australian-made 4-valve '**Selectrodyne**' advertised in 1926 for up to £36/10/0. The cupboard section would normally accommodate the batteries, with the loudspeaker standing on top.

WHEN I THINK BACK

The circuit diagram of yet another 4-valve receiver in this general class appears on page 94 of *The Best of Australia's Wireless Weekly* mentioned earlier. Known as the 'Marco 4', it, along with others like the 'Browning Drake' often featured, in the old days, in arguments between enthusiasts who favoured this receiver or that!

While some such receivers may have been marginally easier to set up and use than others, the chances are that, when optimally adjusted, there would have been very little difference between the performance of contemporary 4-valve 'TRF' receivers — so described because they used a tuned RF stage ahead of the detector.

With hindsight, looking back at some of the circuits, there is good reason to speculate whether the regeneration — or 'reaction' — actually operated around the detector, or the RF amplifier, or both. By offsetting the losses in the associated tuned circuit(s), the end result may have been much the same: boosting the gain and sharpening the selectivity, to a limit set by the onset of active oscillation.

Even without visible feedback circuitry, triode RF amplifier stages, with grid and anode circuits tuned to the same frequency, were prone to oscillation by reason of the valve's own anode/grid capacitance.

Oscillation could be suppressed by using a lower gain valve or reducing the filament voltage with a rheostat; alternatively, the associated coils could be rendered 'lossy' by design or resistive loading — measures which prejudiced gain and possibly selectivity. The answer in many cases, including Fig.3, was to fit a so-called 'Stabiliser' control (see separate panel).

More elaborate TRF designs will be discussed in the next article. In the meantime, AWA (Amalgamated Wireless A'Asia) threw out a major challenge to local manufacturers with a completely different kind of receiver.

The superheterodyne

Conscious of the growing listener demand for improved gain and selectivity, and taking their cue from RCA (Radio Corporation of America), AWA released a range of Australian-made gladiola' superheterodyne receivers (see EA for July 1990, pages 45- 47). As most readers will now know, 'superhets' operated on a quite different principle to conventional receivers using RF

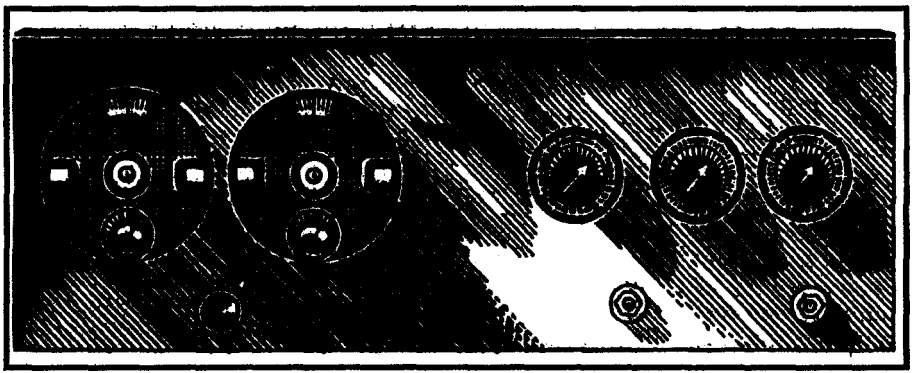


Fig.5: The front panel of an 8-valve battery *superhet*, described for home construction in *Wireless Weekly* for July 29, 1927. The dial on the left is for oscillator tuning; the one to its right tunes the loop, which connects to three terminals at the rear of the receiver.

amplifiers and detectors tuned to the signal frequency.

Briefly, incoming signals were/are 'heterodyned' by an inbuilt tunable oscillator, effectively shifting them down to a much lower, so-called *intermediate* frequency. In the mid 1920's this was typically in the range 50-60kHz. At this reduced frequency, they were passed through a pre-tuned IF (intermediate frequency) amplifier, which could provide much higher gain and better selectivity than was then practicable at the original signal frequency.

The process did not prejudice the original modulation so that, when subsequently fed to a detector, the audio content was recovered in the usual way, hopefully free of interference from other stations. For the user, however, those early *superhets* had certain 'off-putting' peculiarities which set them apart from other receivers of the day. (See Fig.5)

First off, the local oscillator, being tuned within 50-60kHz of the incoming signal, could all too easily radiate a

spurious signal within the broadcast band, creating interference in nearby receivers. To minimise the problem, *superhets* were not normally connected to large outdoor aerials, being used instead with frame aerials sitting atop the receiver and tuned by the receiver's own aerial tuning dial — controlling what came to be known as the 'loop condenser'.

In practice, the signal pickup by a large resonant frame aerial, similar in frontal dimensions to the receiver itself, compared favourably with that of a routine outdoor aerial/earth combination. It offered the further advantage of being directional, such that it could be orientated edge-on to favour a wanted station, and/or broadside-on to reject an interfering signal or even a distant source of static.

Double-spot tuning

A further peculiarity of early *superhets* was that a wanted station could be received with the local oscillator tuned

Price £7:10:0

With Blue Print of Working Plan and, Circuit Diagram.

Fig.6: A coil and IF transformer kit advertised for the 8-valve *superhet* receiver, as illustrated. The IF transformers are wired into circuit much the same as audio transformers. No mention is made of their resonant frequency.

below the station frequency. Always a potential source of confusion, this was commonly referred to as 'double-spot' tuning.

As a corollary of the above, any one setting of the oscillator dial could conceivably bring in two entirely different stations, one above and the other below the oscillator frequency and separated from it by the IF. This came to be known as 'image reception'.

In *Wireless Weekly* for July 29, 1927 (p.36 in the reprint *The Best of Australia's Wireless Weekly — 1927*) readers setting up a home-built 8-valve

superhet were encouraged to experiment with the controls, writing down the best setting for the loop dial for each station and the two possible settings for the oscillator dial. This done, they could double-check their figures and list the best combination for each individual station.

Interestingly enough, in this and similar articles of the period, I found no mention of the actual IF used, nor any reference to pre- or post-IF alignment.

Home hobbyists were simply warned to use only matched sets of IF transformers, connecting them into circuit as per the markings (see **Fig.6**).

While none of the above peculiarities was likely to deter a technically informed listener, they did set the superheterodyne apart as 'peculiar' and perhaps not the wisest choice for the average family, reliant for technical guidance on the average local supplier.

If, as a collector, you come across one of these early **superhets**, don't be surprised by the lack of any information about the intermediate frequency.

As noted earlier, it will probably lie in the region **50-60kHz** and therefore well below the range of any ordinary modulated test oscillator or signal generator.

In such a case, the intermediate frequency could most easily be deduced by pre-setting the receiver oscillator in about mid-range and tuning the signal generator across the broadcast band to identify the two frequencies at which the test signal is heard. The intermediate frequency will be half the difference between them.

For example, with the receiver oscillator at about mid range, signals may be heard from the signal generator when its dial reads either 960 or **1080kHz**.

The difference between the two is **120kHz**, indicating an IF amplifier pre-tuned to **60kHz**. It follows that the receiver oscillator must have been set to **1020kHz** — **60kHz** above **960kHz** and **60kHz** below **1080kHz**.

Ironically, most modern Wien-bridge audio signal generators cover the frequency range up to at least **100kHz**, but the signal would not be modulated. It would have to be observed with a CRO, or as a DC voltage across the detector grid resistor using an electronic voltmeter.

In the second of these articles we shall be looking more closely at the **superhet** configuration in the context of the '30s, when it re-emerged to dominate receiver design for domestic and most other applications — this, for what we described earlier as 'sober, practical reasons'. ■

(To be continued)