When I Think Back...

by Neville Williams

Vintage Radio Design: A smorgasbord of readers' comments, questions and answers

Reader response to the 'Think Back' series has been very gratifying, particularly in respect to the articles to do with vintage receiver design. Some respondents have been most helpful with personal recollections and photostats; others have raised questions, a selection of which form the substance of this present article.

For example, I had just rounded off the article on 3/4-valve superhets when the postman delivered a letter from Keith Walters of Lane Cove, NSW. From past experience, I fully expected a dissertation on video recording, wide-screen TV and satellite links — his pet subjects, with which I can only envy his familiarity.

But no! Behind the contemporary facade of video systems and digital signal processing huts a vintage radio enthusiast. The same Keith Walters who has taken public potshots at the decision makers and intelligentsia of the video scene penned the following paragraphs:

My original enthusiasm for 'ancient' radios was sparked while I was still at school in the late 1960's, by an early Airzone chassis found in a pile of electronic junk that I purchased at an auction for $2. Despite its very 'original' condition, the old warrior worked remarkably well, particularly with a 100-foot (30m) aerial strung up to a backyard mango tree.

With its valve RF amplifier and its 175kHz IF, for gain and selectivity it beat the pants off any transistor radio I had access to at the time. (An often overlooked virtue of even the most humble valve receiver is that you can connect a much larger outside aerial to them than is possible with a transistor set, giving interstate reception without filling the band with chirps and whistles).

Keith says that the set has since become the victim of transformer failure — not readily replaceable because types with 2.5V heater windings are few and far between. Since then he has accumulated a small collection of vintage radios, with cabinets, but none able to match what he remembers as the performance of the old Airzone.

Possible solutions

I can well imagine veteran collectors asking why he doesn't grab the first available 6.3V transformer and see whether he can trade his old 2.5V valves for plug-in equivalents with 6.3V heaters. Or maybe he could dismantle the replacement transformer and substitute a new heater winding, with fewer turns of thicker wire.

Another possible option would be to re-jig the heater wiring so that the 2.5V valves operate in series-parallel from the 5V rectifier winding, with the rectifier running from the 63V winding through a dropping resistor.

Then again, if the 6.3V winding is centre-tapped, earthing this would provide two 3.15V windings which could conceivably power the 2.5V valves through dropping resistors.

This is all secondary, however, to the main thrust of Keith's letter

Your present series of articles have given excellent in-depth explanations of various aspects of early valve receiver design and herein lies a great irony:

I once had a collection of EA/Radio & Hobbies going back to the 1940's and I can't recall any technical articles that provided quite the same attention to detail that your present ones have. Now, two decades on, in the era of compact discs, cellular phones, computers and 16M RAM chips, we have the series! was looking for 20 years ago.

A case in point is the January 1992 article, in particular the part concerning the headaches involved in developing AGC systems.

Keith Walters says that he repaired and passed on to friends three of his not-so-vintage receivers. Duly grateful, they all praised their 'superior tone', which surprised him because the sets all suffered detector-induced distortion, both audible and visible on the oscilloscope. I quote:

Matter of opinion:

No matter what I did at the time, I could not correct it. It was exactly as your article describes — with the various loads removed from the detector, the distortion disappeared.

At the time, I reasoned that the circuit must have worked properly once, so there had to be a faulty component. I replaced all the resistors and capacitors, and even tried wiring a separate 6AL5

Super-regen receivers:

Thank you for your magazine and the excellent series 'When I Think Back'.

How the super-regen detector works has always been a mystery. My version is this: (Please correct me if I'm wrong).

A super-regenerative detector breaks in and out of oscillation ata repetition rate determined by the frequency of the quench voltage.

In his article in the December 1991 issue, Neville Williams mentions the use of super-regen recovers in aircraft during World War II. I would like to add that, to conserve space, they were also used in American submarines. Unfortunately they would radiate a signal 'up the stick', which could be picked up by enemy ships. Some bright spark(?) solved the problem by placing an RF amplifier stage between the detector and the aerial.

(D.C.B., Alderley Old).

diode under the chassis in place of the existing diodes. I also checked the IF transformer, looking for leakage current but there was no sign of that either. So I simply left things as they were.

I no longer have access to the particular radios, but I'm pretty sure that all three sets used simple AGC with the diodes tied together. They must have been real cheapskates in those days, seeing that a proper AGC system would have required only a couple more components. But I do wonder whether the reason they were able to get away with simple AGC in those days had something to do with the programs that were broadcast then. When I was working on the sets, I would almost certainly have been tuned to a 'Top 40' type station, most of which use compression techniques to increase their 'talk power' , thereby operating close to 100% modulation for most of the time. Perhaps in the old days the average modulation depth tended to be much lower than now.

Responding first to the last couple of pars, I will endorse both propositions. In the period we are talking about, most of the music came from 78rpm records, which suffered high distortion arising from the geometry and dynamics of the system, and high noise from the texture of the pressings.

Licensed Announcers

The licences for announcers referred to in the December 1991 article would probably have been those issued by the Ministry of Information — certainly from 1941 (perhaps earlier) to the end of the War.

Announcers who read or commented on news or did outside broadcasts of news events were regarded as journalists. They had to be careful that, in the course of such a broadcast, they did not convey useful tactical information to the enemy — hence the official intervention.

It was actually more of a problem in the UK than in Australia

(Adrian Dunne, Melbourne)

Why all the fuss?

With a source signal of that ilk, and against a background of 1920's-style reproduction, extra detector distortion may not have attracted much attention.

And, yes, diode distortion due to adverse loading rises ,rapidly with the modulation percentage, and artificially high modulation with an otherwise clean signal would inevitably highlight the problem.

As for publishing a design series 20 years too late, I am not sure whether to plead guilty or to suggest that Keith waiters simply didn't arrange to be born soon enough!

The fact is that most of the R&D on which the articles were based was done in the 1930's and published concurrently in company literature and industry publications. It was also the subject of periodic lectures to members of the IRE and WIA and to radio service groups.

It didn't make it *into R&H* because the magazine, as such, didn't appear until April 1939, on the eve of World War II.

By the time civilian radio had returned to normal in the late 1940's, the appropriate course was seemingly to adopt proven techniques without elaboration, and to focus the articles on the practicalities of completing successful projects.

By the 1950's and 60's, reader interest in valve radio receivers was being crowded out by audio systems, test instruments and electronic gadgetry, by TV sets and solid-state technology. While many found the technological rate of change bewildering, they nevertheless expected a 'plain English' coverage from the technical press — and this is primarily what we gave them.

Since then, technological progress has not slowed but, ironically, its bewildering present-day rate has spawned renewed interest in the humble, hand made equipment of yesteryear — which remains sufficiently comprehensible and accessible

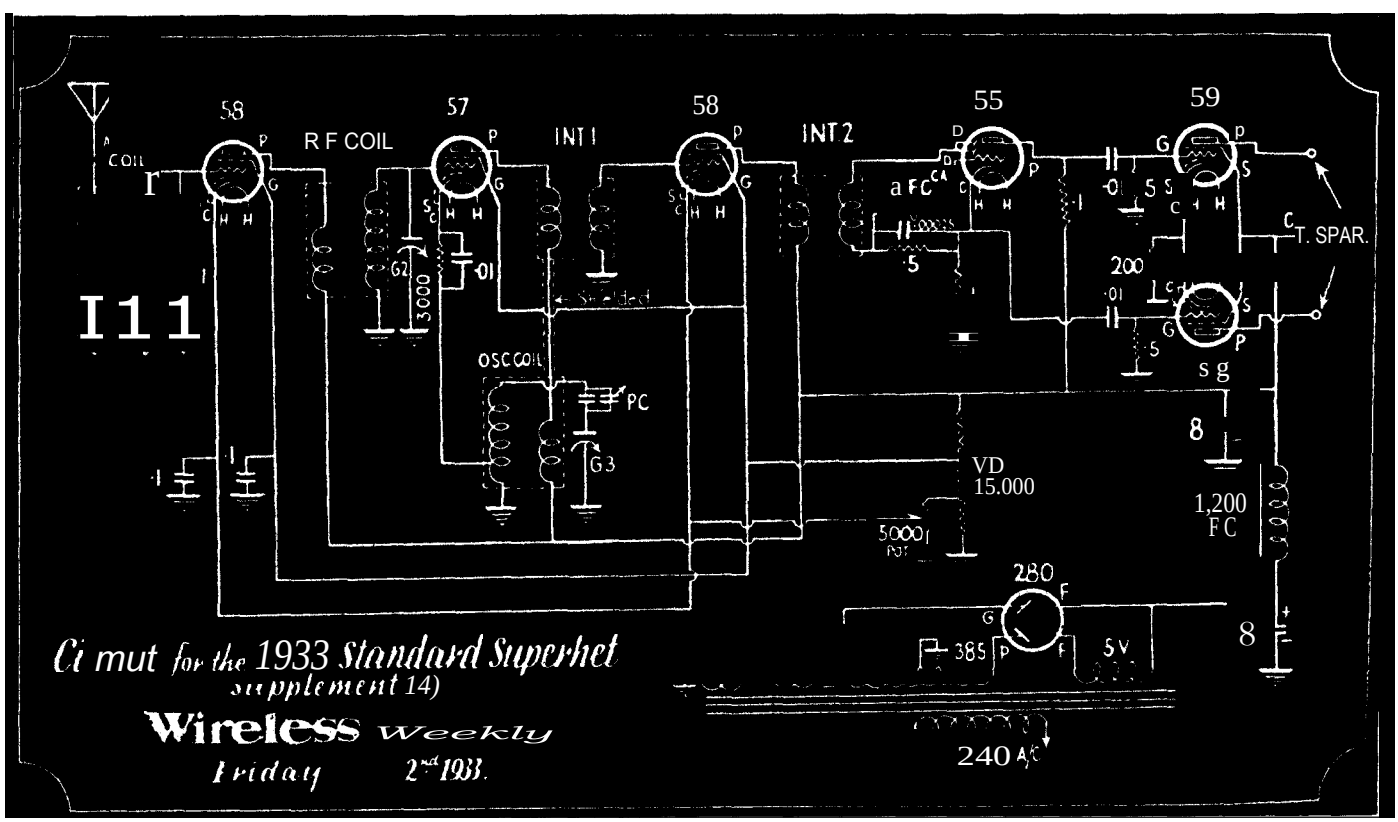

Fig.1: *Inserted as a large blueprint Into 'Wireless Weekly, the circuit of the 1933 Standard Superhet created enormous Interest by its use of a simple resistance-coupled phase splitter to drive push-pull output valves.*

to encourage its acquisition and restoration as a hobby.

What prompted the recent series on vintage receiver design was the realisation that many such hobbyists were clearly unaware of considerations which had featured in industry literature of the 1930's. Most of it has long since been discarded, but I was fortunately able to resurrect a precis of it, with prompting from *Radiotronics,* assorted valve manuals and odd technical journals.

Also on hand were copies of the *Radiotron Designer's Handbook* (third and fourth editions) the latter being a huge 1500-page tome on valve-based technology, complete with more references than you're likely to fmd anywhere else. Had Keith Walters been presented with a copy 20 years ago, he might *have* found less time, since then, to study solid-state video!

All the same, I'm encouraged by his letter and glad that he found the series helpful, even if somewhat belated.

One other point I almost overlooked was Keith's implication that some designers must have been 'cheapskates'. I quoted the remark to one retiree, who used to be a receiver designer for a major manufacturer. I quote: "Keith's obviously never had to work with the kind of accountants I had to cope with. You'd have thought that they had to meet the cost of every extra component out of their own pocket!"

Super-regen receivers

In the panel carrying the above heading, a reader whose name I couldn't quite decipher from his signature invites me to comment on his explanation of how a superregenerative detector works.

To be frank, it's a bit like defining a horse as a four-legged animal. It's true as far as it goes, but it doesn't go far enough; the definition would need to be expanded considerably if the reader was ever to differentiate between a horse and scores of other quadripeds!

It was, in fact, the inadequacy of most such definitions/explanations that prompted the debate, as summarised in the December 1991 issue. If D.C.B.'s 'version' is to give some clue as to how a super-regen. detector really works, he would have to add a further paragraph along these lines:

However, the exact timing, duration and/or amplitude of the oscillatory 'packets' is affected by possible audio signal components on the grid, be they a by-product of system noise or a modulated carrier. In turn, the variations so introduced cause audio-related variations in the mean value of the anode current, which in practice can have an energy level many thousands of times greater than that of the tiny 'samples' that created them in the first place. It is for this reason that a super-regenerative circuit can offer an exceptionally high order of detection gain.

It's possible that the above par could be better expressed, but if D.C.B. can't at least appreciate the point I'm trying to make, I can only suggest that he goes back over the relevant issues, where the matter is discussed at greater length.

In the meantime, thanks for the information about use of superegen receivers on submarines. When lying doggo beneath the waves, about the last thing one would need would be an errant radio signal to attract the attention of enemy destroyers!

Fig.2: In the style of the period, the 1934 Reliance York was housed In an ornate upright console, with lift-up lid giving access to the phono player. Cabinet construction and finish was of exceptional quality.

In that same wartime context, I must also acknowledge a letter from Adrian Dunne of Melbourne, as reproduced in the panel headed 'Licenced Announcers'. It is largely self-explanatory.

According to my Macquarie Book of Events, under legislation enacted following the outbreak of war in 1939, the Department of Information assumed responsibility for the classification of news and other wartime information. Although as a magazine editor I had to observe their directives in regard to restricted information, I did not connect this fact with mention in the December issue of an 'announcer's licence'.

My thanks to you also, Adrian, for jogging our collective memory!

Domestic radio again

From Bathurst NSW, Mr E.G.(Ted) Baker also expresses his gratitude for the 'Think Back' series and adds: "The information in the series is invaluable for the serious radio restorer". He continues:

I wonder if you can comment on the circuit of the '1933 Standard Superhet' (circuit enclosed). I am especially puzzled by the circuit around the 55 diode detector and phase inverter.

Depending on the strength of the received signal, a voltage will be developed across the 0.5meg diode load resistor which will be negative with respect to the cathode. This voltage will be applied directly to the grid of the 55, and one wonders what effect this might have on its operation as a phase inverter.

Did you have any experience with the set? Presumably it operated satisfactorily.

As will be apparent from the circuit (Fig.1,) the receiver in question was unveiled on June 2, 1933 — by which time I had been employed in the radio industry for less than six months, for the princely sum of one pound ($2) per week. As such, I was in no position either to evaluate the design or to invest in a kit of parts to build one. My reactions to the circuit are therefore all of the hindsight variety.

With an RF stage ahead of an autodyne frequency changer, IF amplifier and diode detector, the front-end gain and selectivity would have been well ahead of the ordinary 4/5-valve domestic superhets of the day. While this would have set the receiver apart, the real point of interest was in the push-pull output stage — offering double the usual audio power.

Push-pull output stages were not new in 1933, but most relied on push-pull grid drive transformers, which were either very costly or characterised by an indifferent frequency response. Moreover, in mains powered equipment, they were prone to hum pick-up from the magnetic field of the power transformer.

The 1933 Standard sidestepped such problems by using a 'phase-splitter' stage, with its effective output load being formed by two identical resistors, one in the anode/HT+ circuit, the other in the HT-/cathode return.

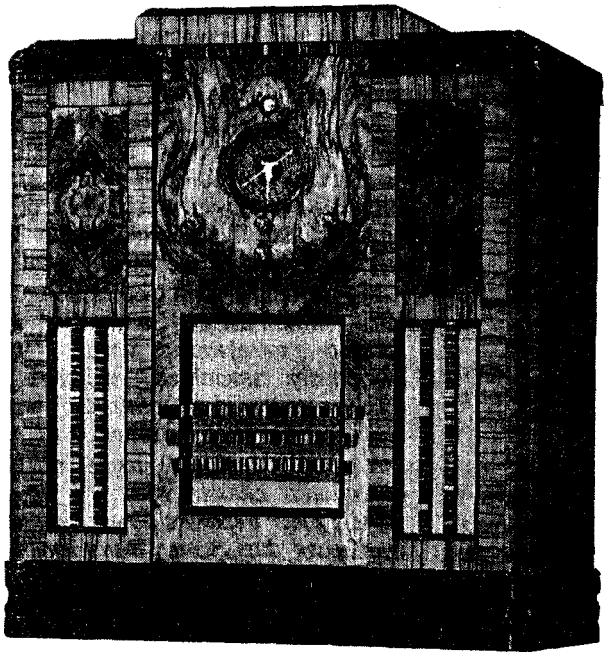

***Fig.3:** Still in keeping with the industry trend, the 1936 'York' was housed in a lough-boy-style cabinet. It featured automatic volume expansion and, unlike other receivers, retained a push-pull triode output stage.*

Suppose, in Fig.!, that a positive-going signal at the grid of the 55 caused the anode current to cycle through an upward excursion of 0.1mA. This would produce a resultant voltage drop at the anode of 10V, representing a negative-going 10V pulse at the grid of the upper output valve.

Meanwhile, the same upward excursion in anode current would cause a positive-going 10V pulse at the cathode of the 55, and therefore at the grid of the lower output valve. In short, by sharing, its load equally between anode and cathode, output from the 55 was separated into two signals of opposite phase.

I have forgotten who first devised the above phase splitting circuit, or when, but for most readers in 1933, the idea was both novel and intriguing. The end result was a receiver that was sensitive, selective and unusually powerful, without being unduly complicated or costly.

As such, it rewarded the ***Wireless Weekly*** initiative, boosted the do-it-yourself market and posed an implicit challenge to the manufacturers of routine 4/5-valve superhets. If you come across one, it could certainly be worth restoring.

The Standard did have certain in-built limitations, however. Because half the output signal appeared across the cathode circuit, normal stage gain could only be realised if the audio input signal was injected between grid and cathode of the 55 triode.

In respect to radio signals, this was achieved quite simply in the 1933 Standard by processing the IF signal and the recovered audio directly between the diodes, cathode and grid, independently of earth.

Unfortunately, the arrangement rendererd the circuit unsuitable for use with a phono pickup — because in the normal way, a pickup signal would have had to be injected between grid and earth. In this mode, the output signal present across the unbypassed cathode resistor would result in a high level of negative feedback, reducing the effective per-channel gain of the 55 triode to less that unity, instead of something over three.

Again, because the entire diode/cathode circuit was pegged above earth by 50 volts or so, the system was not available for automatic gain control.

Fortunately for promoters of the 1933 Standard Superhet, prospective constructors in 1933 were not particularly concerned by these restrictions and it was equally too early in the scheme of things to question the lack of negative feedback around the output stage. It would not have been practical, anyway.

What then about the point raised by Ted Baker: direct application of the diode voltage to the grid of the 55?

First off, the diode voltage did not depend, as Ted has assumed, on the strength of the received signal — because of the manual RF/IF gain control. To work out why becomes an exercise in thinking backwards from the loudspeaker end.

In everyday use, the RF/IF gain control would be set so that the volume from the loudspeaker would be at normal listening level. The drive signal to the 59 output valves would therefore be maintained at a similarly 'normal' level, as also would be the signal fed through the 55 from the diodes.

In short, whether the incoming carrier was strong or weak, the manual gain control would be so set as to feed a substantially uniform IF signal to the diodes.

The question therefore becomes simply a matter of whether the voltage generated by the diodes would be an appropriate bias for the 55, with the detector/audio system operating at a normal listening level.

Without getting bogged down in theory, the 55 had a very low amplification factor (8.3) and was fairly accommodating in respect to the applied bias — especially when operating into a high value load from a high voltage source. All the evidence suggests that, in the 1933 Standard circuit, direct coupling worked well and there was no point in complicating matters by inserting a coupling capacitor and a grid return back to a tapping on the cathode load.

It was/is of no account that the 55 triode happened to be working into a split load. In terms of grid/anode dynamics, the valve was simply operating as a voltage amplifier into a nett load of 0.2meg (200k), with a supply voltage of around 300 and a (hopefully) acceptable external bias.

Valve 'monstrosity'?

Some time back, I received a letter from Darryl Kasch, then working with 2GZ in Orange, NSW. Caught up with vintage radio, he had assembled a collection of 1930's-style receivers. Darryl had also worked through the files of ***Wireless Weekly*** for the same decade, in Sydney's Mitchell Library and extracted a wad of relevant photostats.

In the process, he had come across references to the 'York' receiver, manufactured by Reliance Radio of Sydney — variously located in Clarence St, then York St and finally Barrack St, City, alongside the Lottery Office.

His first reaction to the York was that it was an expensive, over-designed 'monstrosity', inspired by the American, chrome-plated E.H. Scott receiver. He had heard (wrongly) that I had originally designed it and was seeking further information.

In more recent correspondence from Maryborough, where he is now associated with 4MB, Darryl says that his collection of vintage receivers topped the hundred before he 'cut back', but he had still not managed to locate a Reliance York. In the meantime, based on what he had heard and read about it, he

had decided that the York must have been an impressive receiver in terms of tonal quality. Indeed, he suggests, it could conceivably qualify Reliance as the birthplace of 'custom-built hifi' in Australia.

That Darryl hasn't come across a York receiver is not surprising because, for the most part, they were manufactured as one-off specials to meet specific needs. Whether this would confer pioneer `custom' status is another matter.

Apart from a personal interest in hili equipment, the management of Reliance saw merit in displaying a deluxe receiver, where practicable, at shows and exhibitions. They attracted attention and generated publicity in the press. And after the show, some well-heeled business executive would usually be waiting, cheque in hand, with the further possibility that one or other of his/her friends would line up for 'the next one you produce'. It certainly helped confer a quality image on what was essentially a small family company.

`Leading edge' design

Described as 'Australia's Outstanding Achievement in Radio', the first Reliance 'York' advertisement pinpointed by Darryl Kasch appeared in *Wireless Weekly* for December 8, 1933. Editorial coverage in the same issue indicated that it was available with or without in-built record player, in a 'massive' but modestly embellished upright console cabinet.

The chassis and all exposed metalwork appeared to be chromium plated, accommodating a 9-valve circuit, a 4-gang tuning capacitor and drum dial, with preselector and RF stages ahead of the frequency changer. The audio system featured an almost legendary Ferranti transformer feeding push-pull 45 triodes and driving an imported Jensen D8, 10-1/2" (27cm) 'concert' loudspeaker.

In fact, during 1933, the newly established Reliance factory had problems enough coping with the production of standard models and, curiously, I have no recollection whatever of the above-mentioned York. Either my memory has slipped a cog, or the requisite few Yorks were assembled privately elsewhere.

I do, however, remember the model that followed it. Described as 'Australia's Most Luxurious Radio Reproducer', it was featured in *Wireless Weekly for* December 14, 1934 (Fig.2).

The advert showed an ornate, upright console, of piano-finished burr walnut,

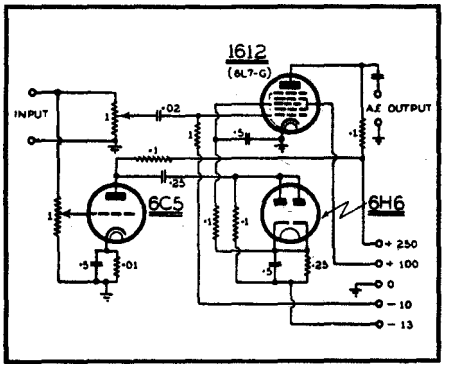

Fig.4: Basic automatic volume expansion circuit from the 'Radiotron Designer's Handbook, 3rd edition, p.74

with sculptured cathedral-like panels to frame the controls and serve as 'diffused' sound outlets. I well remember the fuss when the cabinets were delivered by Ricketts and Thorpe, the detailed inspections by Reliance executives and the apprehension when cabinet fitter Vic Inkster — a husky Harbord lifesaver — took to them with handtools to accommodate the equipment.

For a model produced in 1934, the basic design would have been the work of Norman Martin, my immediate senior and mentor in the Reliance factory. My subsequent contribution would have been to the assembly and wiring routines and, later, final adjustment.

At the time, Ray Tonks, mentioned some time back as a 'build your own Hammond' organ buff, was also working at Reliance, initially in the factory and later on field delivery, installation and service. For transport, he and his cohorts used the 1934 equivalent of a 'ute': a Harley-Davidson motor cycle with a large box sidecar. (By observation, riding a big Harley around Sydney on wintery, wet days was a much overrated pastime!)

Ray Tonks, after a subsequent stint in AWA Special Products at Ashfield, is now retired on the NSW mid-coast. He still has a clear, mental picture of me aligning and final checking the York receivers which he had later to install.

My own most vivid recollection of the 1934 'Yorks' involved a stack of gold-sprayed metalwork which, when laboriously assembled, enclosed the receiver proper in a largish steel box. It was described in advertisements *as:*

A totally enclosed, triple shielded, tuner/audio chassis with full floating valve panels. Separate power chassis — two heavy duty power transformers — two rectifiers, elaborate filtering.

Advanced circuitry

The 10-valve circuit specifications also suggest a 'nothing but the latest' approach.

In 1934, the York was offering a triple-wave tuner, with automatic gain control and a rare feature which I have not previously mentioned: automatic muting. Between stations, when an AGC equipped tuner might ordinarily reproduce loud static or electrical interference, the audio end was automatically muted so that otherwise rude noises were silenced. The system 'un-muted' immediately a regular signal was tuned, to permit normal reproduction.

Again, at a time when most other manufacturers had traded sound quality for the extra gain offered by power pentodes, the Reliance York was one of the

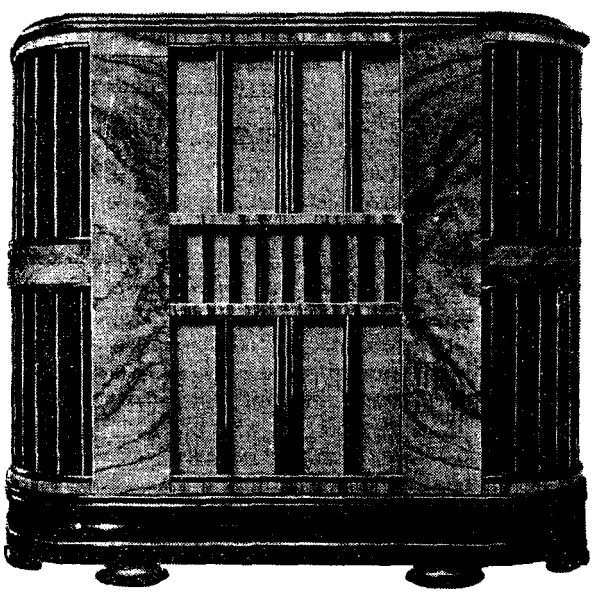

Fig.5: A prime example of elaborate cabinet work housing twin permag. auditorium loudspeakers, for the 1937 Reliance York. ft was connected to the equipment cabinet via a 200-ohm line.

very few commercial receivers which retained power triodes, in the form of push-pull 45's. The power available would have been in the range 5 to 10W, depending on the operating conditions — which I have long since forgotten.

Their output was fed to a top quality American 29cm auditorium loudspeaker, from Jensen or Magnavox, which offered high sensitivity, extended frequency response and smooth, powerful bass.

To those of us who worked on them, the 1934 'Yorks' were totally 'over the top' for ordinary families. I still remember the amazement of the Reliance sales staff when a very humble old lady from a very humble address walked into the showroom and ordered a York — for no other reason than she wanted to own in her lifetime at least one thing that was `the best'!

Re-reading the advertisement through 1992 bi-focals, the wholesale price for `this magnificent instrument', direct from the manufacturers, doesn't seem all that steep: £4$^{9}/_{1}$6/8. In truth, for an average family man in those days, 'fifty quid' could have meant 10 weeks' wages — around $4000-5000 in today's currency. It was, undoubtedly, a radio for the rich; a wireless for the well-to-do!

Later model Yorks

An advert in *Wireless Weekly* for July 3,1936 illustrates a still later model York — presented in a completely new, rectangular 'loughboy'-style cabinet in piano-finished 'Italian burr walnut and mocasser ebony'. The price had risen to 75 guineas (£78.15.0), with Reliance conceding that it was 'admittedly not for the average home'.

The chassis is/was described in precisely the same terms — totally enclosed, triple shielded, floating valve panels, two heavy duty transformers, etc. — but it carried two extra valves plus a magic eye. A similar audio system was retained, with an imported loudspeaker, but this time around, it featured automatic volume expansion as well as automatic muting netween stations.

As I recall, the automatic volume expansion was based on an arrangement which had been devised by RCA and published in their early application data for the 6L7 pentagrid mixer/amplifier. The circuit was subsequently reproduced in the third edition of the *Radiotron Designer's Handbook* (Fig.4).

It involved using the 6L7 (or its low-noise equivalent 1612) as the first stage in the audio amplifier. At the same time, some of the input was diverted to a 6C5 triode and fed thence to a 6H6 diode, which converted the audio signal to a resultant DC voltage. This was fed to grid-3 of the 6L7, such that the stage gain of the 6L7 would increase progressively with a louder signal.

The prime purpose of so doing was to expand the dynamic range of 78rpm discs, which had customarily been compressed at the recording stage as a precaution against system overload.

For acceptable results, the user had to exercise discretion regarding when to activate the expansion and how far to advance the expansion control.

Used to excess or on programs which did not warrant its use, the result could be disconcerting, with louder passages surging in volume in a quite artificial way.

We soon learned at Reliance that the most tractable music for an introductory demonstration was a theatre organ recital, by the likes of Reginald Dixon. By their very nature, such recitals relied on gentle, romantic passages and dramatic crescendos — with volume expansion, working into a generous loudspeaker system, adding predictably to the effect.

Meanwhile, around 1936, we had been pursuing developments aimed at increasing the power capability of the York amplifier, extending to the possible use of 2A3's or 6L6's instead of the existing 45's.

I well remember a conference on the subject with the late Fritz Langford-Smith of the AWV Co., which saw the big triodes installed in the developmental prototype. Unfortunately, about that same time, Reliance was hit with a liquidity crisis and both Norm Martin and I accepted other positions.

What happened after that I'm not sure, but a feature on the 1937 Reliance York in *Wireless Weekly* for December 17, 1937 revealed an extension of the earlier circuitry to 19 valves — including twin rectifiers and four 2A3's in push-pull parallel driving twin imported permagnetic loudspeakers.

A four-band tuner was provided, with a measure of bandspread at the highest frequencies. The set was housed in two separate cabinets with the 'works', once again chromium-plated, in a solid, richly veneered chest. The loudspeakers were in a separate, massive sculptured enclosure with tapestry-backed apertures at the front and sides.

While this was before the era of mathematically derived systems, by any standards (and especially by those of 1937) two large concert loudspeakers in a massive cabinet, driven by four 2A3's could only sound very impressive.

I'm sure Darryl Kasch would love to get hold of one — assuming that he could find somewhere to put it!