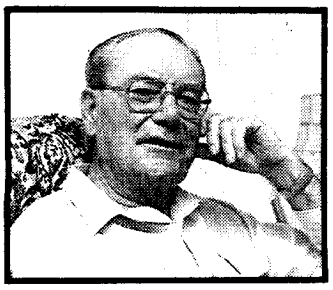


When I Think Back...

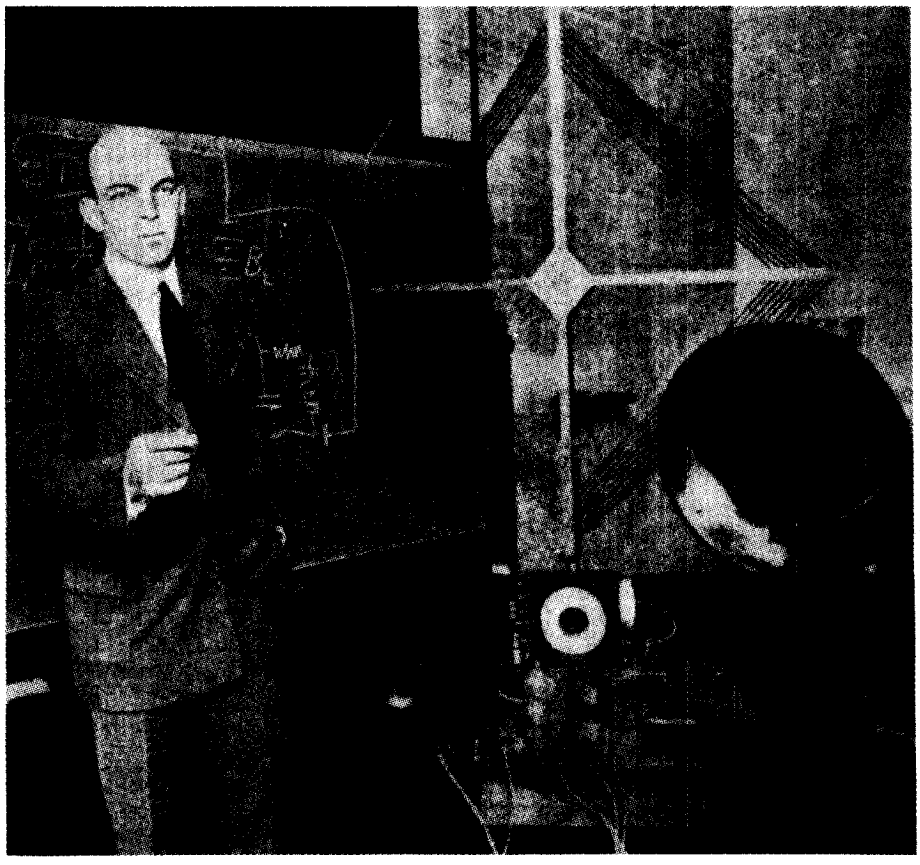
by Neville Williams

Major Edwin Howard Armstrong: a genius who lost the will to live – 2

Although with the benefit of hindsight Armstrong's main achievements were almost certainly the discovery of the valve oscillator and the development of the superhet, his inventive genius didn't stop there. Another of his inventions was the super-regenerative receiver, which played a worthwhile – though short lived – role in opening up VHF/UHF communications. He also played a key role in the development of FM broadcasting.

Armstrong's next invention came hard on the heels of the superheterodyne. Spelt nowadays without the hyphen as 'superregeneration', it was patented in 1922 and described in a paper to the Institute of Radio Engineers (USA) in June of that year.

Surprisingly, I found no less than eight articles on the subject in a bound volume of *The Australasian Wireless Review* for 1923, directed to readers who might be inclined to try out the new circuit.



From the June '23 issue of 'Australasian Wireless Review' Howard Armstrong is pictured in the formal role of inventor and academic, demonstrating his superregenerative receiver. Contrary to some reports, he always regarded the superhet as the more elegant approach.

Unfortunately, none had the advantage, like the superhet article above, of being written by the inventor; rather by unnamed staff members, who seemed to be uncertain as to how the circuit was supposed to work (see panel). Having read through the articles, I could only hope that they meant more to enthusiasts working with prototypes than to someone merely reading the text, the best part of 70 years later!

I was reminded, however, of a time when the amateur fraternity – myself included – was probing the VHF and UHF spectrum using simple modulated-oscillator transmitters and superregenerative receivers.

Although brief, the literature from that period was somewhat more enlightening.

It was pointed out that superregeneration could be regarded as a potential elaboration of any regenerative detector, capable of sustained oscillation at the required signal frequency.

It involved the addition of an external oscillator, which could modulate the grid and/or anode voltage of the detector so that its signal frequency oscillation would be interrupted at a suitable supersonic frequency. A simpler alternative was to choose the value of the grid capacitor and resistor to achieve an artificially long time constant, so that the grid would 'block' or 'squegg' at a supersonic frequency when oscillating, thereby functioning as a 'self-quenched' superregenerative detector.

Basic principle

The accepted, if rather superficial, ex-

planation of how the circuit worked started from the premise that when an ordinary regenerative detector went into oscillation, its operating point (or bias) shifted in such a way that extra positive feedback did not further increase detection efficiency. As well, the audible beat note between the incoming and local signal corrupted the modulation.

In a superregenerative receiver, the detector effectively 'sampled' the incoming signal at a supersonic rate with high positive feedback – but with less effect on efficiency – providing a substantial increase in sensitivity and obviating the audible heterodyne.

Even so, the superregenerative circuit had a few problems of its own: the need for special components to generate the quench signal, and then to filter it out to prevent overload effects in the audio amplifier; uncertainty about circuit adjustment and behaviour; high noise level in the absence of signal; poor selectivity; and a tendency to radiate noise interference into nearby receivers.

According to *Electronics Weekly* Armstrong sold rights to the circuit to RCA for $200,000 plus 60,000 shares, most of which was absorbed by Armstrong's on-going litigation. For RCA, the 'superregen' circuit proved of little commercial value, although it was used from the 1930s onwards by amateur operators for simple receivers, and by modellers for radio control purposes.

Readers may be interested in a quote from the *ARRL Handbook* for 1936:

The student of the subject anxious to have a more thorough knowledge of theoretical considerations might well study the excellent technical treatment by Ataka in the August 1935 issue of 'The Proceedings of the Institute of Radio Engineers' (USA).

I have not seen it personally.

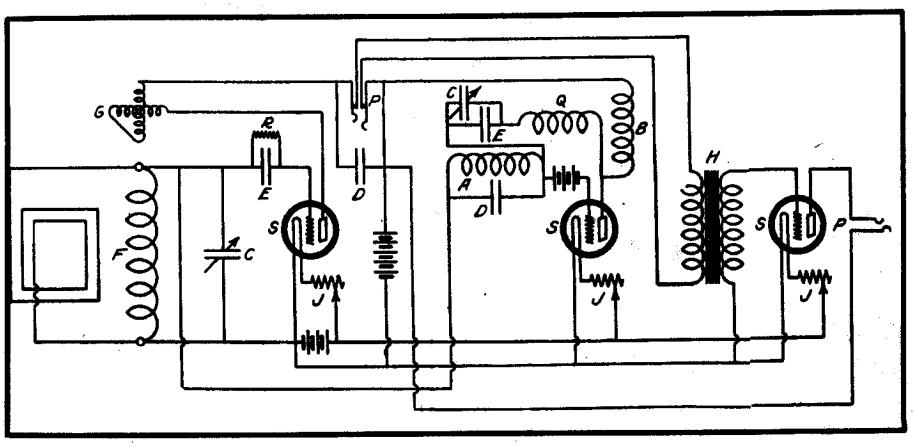


Fig.3: The 3-valve superregenerative circuit selected for construction and test by 'The Australasian Wireless Review' in 1923. On the left is the regenerative detector using a variometer for adjustable reaction. The quench oscillator (centre) feeds its signal to the detector grid. On the right is an audio amplifier stage. All valves are UV-201 tungsten filament triodes.

Frequency modulation

With his wide-ranging background, Armstrong was well aware of the problem posed by atmospheric and man-made interference. As far back as 1914, he had studied it in collaboration with Professor Pupin, but by 1922 both had accepted that sensitivity to interference was intrinsic to any receiver required to respond to variations in the *amplitude* of incoming signals.

So, while other engineers and experimenters continued vainly to dream about anti-static measures, Armstrong turned his attention to the possibility of a system which would depend on *frequency* modulation of the carrier wave – a method which would allow the receiver to be so designed that it would specifically *reject* amplitude modulation, and therefore noise interference as well.

Frequency modulation had been a long-time option, and Armstrong never claimed to have originated the idea. In his book *Radio Telephony* (Wireless Press Inc, 1918), Alfred N. Goldsmith PhD mentions FM, but discards it. But with other engineers rejecting it as impractical, Armstrong set about to demonstrate otherwise – winning, this time, the backing of GE (the General Electric Co, of Schenectady, USA).

As mentioned in earlier articles about Raymond Allsop and FM broadcasting in Australia, Armstrong's early research culminated in a paper published in May 1936 in *The Proceedings of the IRE* (USA), entitled 'A method of reducing disturbances in radio signalling by a system of frequency modulation'.

His claims were supported by an impressive practical presentation to the Radio Club of America, in the Pupin Hall of the Columbia University – an audience and a locale richly reminiscent of other days. The source of the signals was a 2kW RCA-built transmitter atop the Empire State building. Supporting papers were also delivered by Messrs Weir, Flyer and Worcester of GE.

Hassles with home-built superregen receivers:

The following are a few snippets from 1923 issues of *The Australasian Wireless Review*, which could hardly have been reassuring to would-be constructors:

March, p.19: *Many thousands of American amateurs are working hard to master the intricacies of the superregenerative circuit and it is hoped that Australian amateurs will not lag far behind in bringing the circuit into successful operation here.*

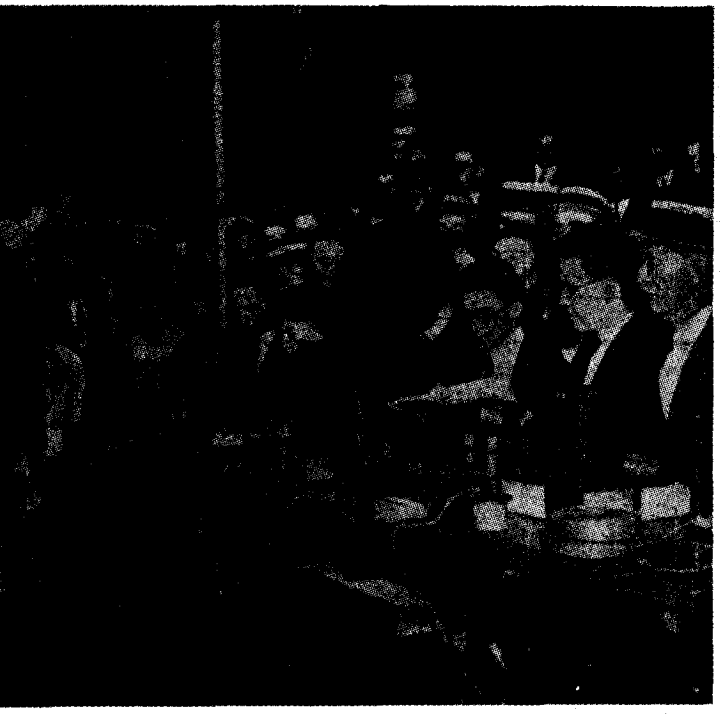
April, p.22: *Apparently it is only a matter of patience and experiment to get the circuit working correctly, as every change reveals some new feature of the circuit that seems to bring one nearer the goal.*

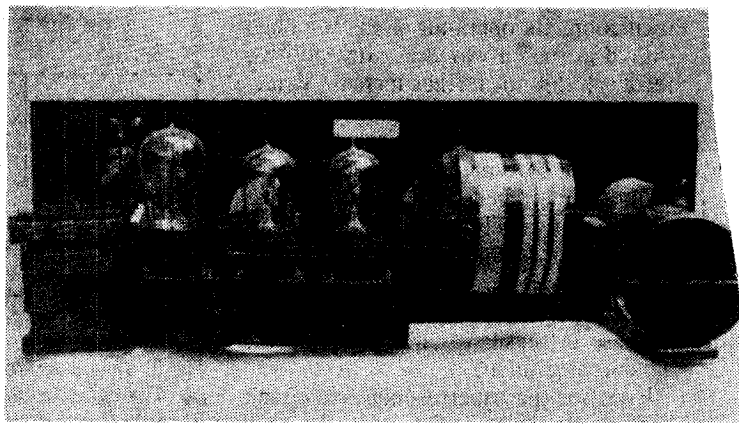
April, p.22: *The word 'roar' very appropriately describes the noise heard, as it is as loud as the safety valve of a steam engine blowing off. It convinces one that there is tremendous power in the circuit, if it can only be brought under control.*

April, p.27: *When the two valves are oscillating, the movement of any of the variable elements should produce a series of heterodynes or harmonics. Unless these are heard, there is something wrong and no progress can be made.*

June, p.26: *It will be noted that long ebonite handles control the moving elements, with the object of overcoming body capacity effect, which experiments with the Armstrong superregenerative circuit prove to be very great.*

August, p.40: *We have a good deal to learn about it yet to get maximum results, but we are satisfied in having, at last, made the Armstrong Super work.*





(Above). Headlined as 'The first Armstrong Super to work in Sydney' this superregenerative receiver was constructed by Mr Fry of the Universal Electric Company of 244 Pitt St, Sydney. Readers wanting to buy similar parts to those used were invited to contact the above company.

(Left). When Armstrong demonstrated the superregenerative receiver at Columbia University, the audience crowded around the display.

FM broadcasting

Within three years, Armstrong's dream was well on the way to becoming a reality. In April 1939, under the heading 'At Long Last – STATIC-FREE RADIO', the US magazine *Radio-Craft* carried an announcement by Armstrong that the world's first static-free broadcast station was currently being set up as a personal investment.

To be known as W2XMN, the station would be classified by the FCC as experimental, but would hopefully be granted a commercial licence if it proved successful. It would transmit from atop the Pallisades (New Jersey) near the George Washington bridge, on a wavelength of about 7 metres (40MHz) and would serve an area of about 100 miles (160km) diameter. It would broadcast programs originated by New York's hifi AM station WQXR, until such times that WQXR had installed its own FM outlet.

In the meantime, according to the article, two experimental FM stations were already in operation – one in Albany, NY, operated by GE and another installed by the Connecticut State College at Storrs, Conn. Six other experimental stations were being set up elsewhere by engineers who believed that FM had great potential.

GE, said the article, had begun manufacturing FM receivers and Edwin Armstrong is pictured with GE's Dr W.R.G. Baker checking out an 11-tube laboratory prototype.

Another picture shows Armstrong swinging in a boatswain's chair 400ft (120m) up on W2XMN's transmitting tower, adjusting the VHF antenna elements and cable feed system. Occupying several hours a day, spread over 2 months, this was described as the most difficult part of the whole project.

The development of FM broadcasting was interrupted by the war, however, with Armstrong granting free use of his many patents to the US Government and diverting his immediate attention to military radar.

After the war, FM broadcasting emerged as an outstanding success, spreading across America and into Europe and other technologically advanced nations – to the dismay of established AM commercial broadcasters. Millions of FM receivers have been built and sold around the world, virtually every one of them a superhet!

High personal cost

From amateur to academic, as an innovator, inventor and visionary, Edwin Howard Armstrong must rate among the all-time greats in the history of radio and electronics technology.

But at a personal level, his dedication and his unwillingness ever to 'let go' cost him dearly. He supported his convictions passionately and, when faced with litigation, he drained his emotional and financial resources to defend what he saw as principles. Although in no sense a recluse, his preoccupation with technical and business problems created a work overload, robbed him of relaxation and undermined his health.

The British pioneer, Captain H.J. Round was to say later: "Howard tried to do it all himself and it was too much even for his great intellect and personality."

Marconi's biographer, David Gunstan, adds the remark that Armstrong developed "an almost paranoid conviction that he was the victim of conspiracy".

His career ended on January 13, 1954, exactly 41 years to the day in 1913 when the 22-year old graduate of Columbia University had some circuit diagrams witnessed by a notary public.

Having written a letter to his wife, Edwin Howard Armstrong put on his hat, overcoat and gloves as if to go out for the evening. But instead, say the reports, he climbed through his 13th-story apartment window and crashed to his death on a third floor terrace. There his body remained until someone noticed it mid-morning the next day.

From *Electronics Weekly* I borrow this fitting tribute:

So passed from the scene a brilliant, controversial, inventive genius of whom it was said: the radio art owes more than to any other one man. Today there is no radio system anywhere in the world that does not use his ideas in some way. EA