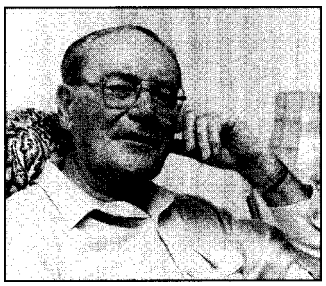


When I Think Back...

by Neville Williams

Maxwell Howden: Pioneering quartz crystal manufacture in Australia (2)

Having pioneered two-way amateur radio from Australia to the USA and Britain using shorter wavelengths (higher frequencies), Maxwell Howden turned his attention to the technology and production of quartz crystals. In due course, he became a major supplier to the local electronics industry, the Royal Flying Doctor Service and the Armed Forces.

Born in 1899, Max Howden became involved in radio at a time when the technology was based predominantly on sparks and arcs. It wasn't until around 1920, coincident with the re-emergence of the Wireless Institute of Australia, that Max and his fellow enthusiasts could abandon the old technology.

From then on, throughout the 1920s, enthusiasts tended to concentrate on emerging valve circuit configurations, with some receivers distinguished by fancy names: e.g. 'Philips P1', 'Marco 4', 'Browning Drake' and so on. Others represented departures in basic circuit principles: multi-stage TRF, neutrodyne, superregeneration and super-heterodyne.

Max Howden was up to his ears in this technical scramble — except, it would appear, that he favoured simplicity with efficiency rather than brute force. He made special point of the fact that he had won the Transpacific competition using a humble three-valve receiver. What intrigued me, as I prepared this biography, is how he also found time to become so deeply involved in quartz crystals.

Modern crystallography, I gather, dates back to about 1912, when it was discovered that crystals could be identified and analysed by X-ray diffraction; this along with the so-called piezoelectric effect, by which certain crystals — e.g. quartz — were shown to change their dimensions when subjected to electrical stress. The reverse proved also to be true: when stressed mechanically, some crystals produced an EMF between certain faces.

In practice, piezoelectric crystals found little application in wireless/radio communication during the aforementioned 'arcs and sparks' era, having to await the emergence of valve technology — and thereafter grow with it. The question was, when and how?

Max Howden in his prime, through the eyes of illustrator L.F. Reynolds. Writer C.R. Bradish suggested that, for someone who so often devoted the wee small hours to long distance radio, shaving was an unacceptable intrusion!

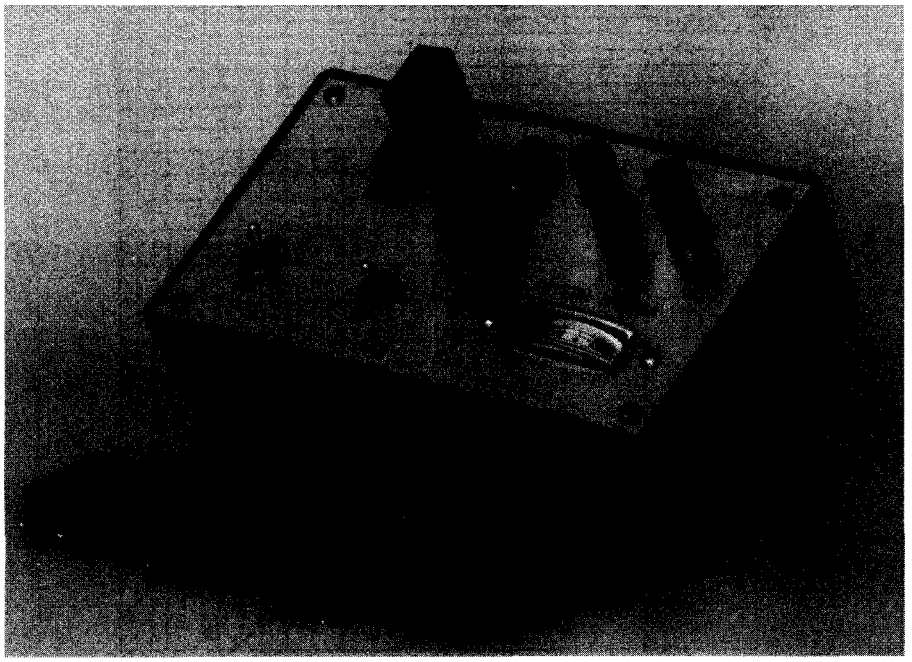
Early knowledge

Looking back through my original 1931 copy of the *Admiralty Handbook*, I came across a segment on quartz crystals, cheek by jowl with traditional (and obsolete) Royal Navy wireless technology. It explained how crystals could be cut and ground to produce a wafer exhibiting an electro-mechanical — or piezoelectric — resonance effect, at a selected frequency within the RF spectrum. Furthermore, if such a crystal were used in a valve oscillator stage in place of the usual L/C resonant circuit, the valve would oscillate at the natural piezoelectric frequency of the wafer. More to the point, the slab would behave as if it had a 'Q' factor (or `selectivity' curve) far superior to that of any conventional L/C tuned circuit, such that the oscillator would be effectively locked to the frequency for which the crystal had been ground.

Searching further through early references, I came across my 1936 copy of the *ARRL Handbook*, with text that had originally been revised and updated by Ross Hull, an expatriate `Aussie' and a Melbourne amateur, who would have associated with Max Howden in the 1920s.

The *ARRL Handbook* illustrated the shape of a natural quartz crystal, explained its inherent structural axes, and the special slab 'cuts' which could be exploited to minimise the effect of temperature on its resonant frequency.

The writer went on to stress that special equipment was required to identify the axes of any given crystal, and to cut suitable slabs for subsequent grinding. The techniques and skills involved were confidential to the manufacturers.



Described by then staff member Ian Pogson in the June 1978 issue, this simple Crystal Checker was used to check the author's collection of vintage crystals — mainly in FT-243 packages.

Typical blanks were about one inch (25mm) square, with variants somewhat smaller and of rectangular shape.

Few amateurs, he added, attempted to cut their own blanks, preferring to buy pre-cut -X, -Y or -AT blanks which they could then proceed to grind into functional crystals. At the time this was a table-top exercise calling for fine grade carborundum powder, an offcut of plate glass to serve as a bed plate and a generous helping of time and patience.

An accompanying diagram showed the relationship between the thickness of typical blanks and the fundamental frequency. Amateurs attempting to grind their own crystal could use a micrometer to check progress and flatness, but a test oscillator and a calibrated receiver was essential to keep track of the precise frequency.

A decade earlier!

But this was in 1936. One could only boggle at the notion of Max Howden, the best part of a decade earlier, and with little to go on, attacking a lump of glass-hard crystalline quartz with carborundum cloth wrapped around the blunt side of a hacksaw blade!

Little wonder that he settled instead for a diamond saw, while Jock Howden looked on, wondering whether his younger brother had taken leave of his senses...

In fact, Max was not simply following the lead of other enterprising amateurs; he was working things out the hard way and gathering information which would be disseminated to other enthusiasts, over the air and via handbooks and magazines.

Some of his early observations about crystals were published in an article in the American ARRL magazine ***QST*** for November 1929, headed: ***EXPERIMENTERS' SECTION — New Crystal Fragments, by Maxwell Howden VK3BQ.***

It took me a while to work out that he wasn't referring to fragments of crystals, but to new fragments of information about crystals.

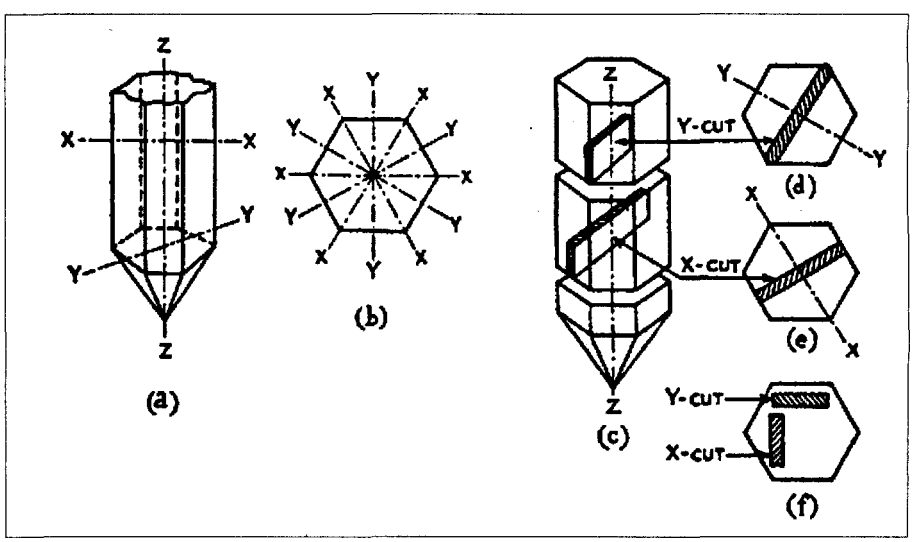
Max remarks that relatively few American amateurs seemed to be opting for crystal control — possibly because, over and above the cost of the crystal, the associated circuitry suggested in ham literature was often needlessly complicated.

In Australia, by contrast, the interest in crystal control was proportionately much higher. Much of the crystalline quartz came from the Mount Lofty Ranges near Adelaide, and amateurs ground their own, mostly for use in the 3.5MHz (80m) band.

A simple single-stage transmitter comprising a 201A triode, crystal controlled, could distribute a Morse Code signal across Australia and New Zealand, representing roughly the same area as the USA. Add a single 210 or two in parallel as a power amplifier, and there would be power to spare.

The essential difference between the two countries was the amount of interference in the USA arising from the huge number of active amateurs in that country. In that environment, power output seemed more important than stability!

Max then goes on to detail his observations when grinding crystals for the 3.5MHz band. It was not at all unusual for a crystal to oscillate in harmonic mode, as distinct from the desired frequency. The unwanted mode could often be either reinforced or suppressed by selectively grinding the corners — or making the chip, overall, ever-so-slightly concave or convex. Mention is also made of the energy level applied to the wafer, and the possibility of causing the



The physics of a quartz crystal as presented in the ARRL Handbook for 1936. Max Howden was struggling to come to terms with all this when he told of his experiences in an article in QST, for November 1929.

crystal to puncture or even shatter if over-excited.

Published back in 1929, the content is far too 'fragmented' to summarise or to qualify as 'How to' reading. What it does signify is the amount of time Max must have devoted to grinding crystals in the late 20s, putting him in an advantageous position to supply blanks cut to specified axes, and/or wafers and holders ground to specified frequencies. In short, practical experience gained as an amateur in the late 20s and early 30s opened the way to a career as a manufacturer and supplier of crystals, in the decades that followed.

Crucial visit

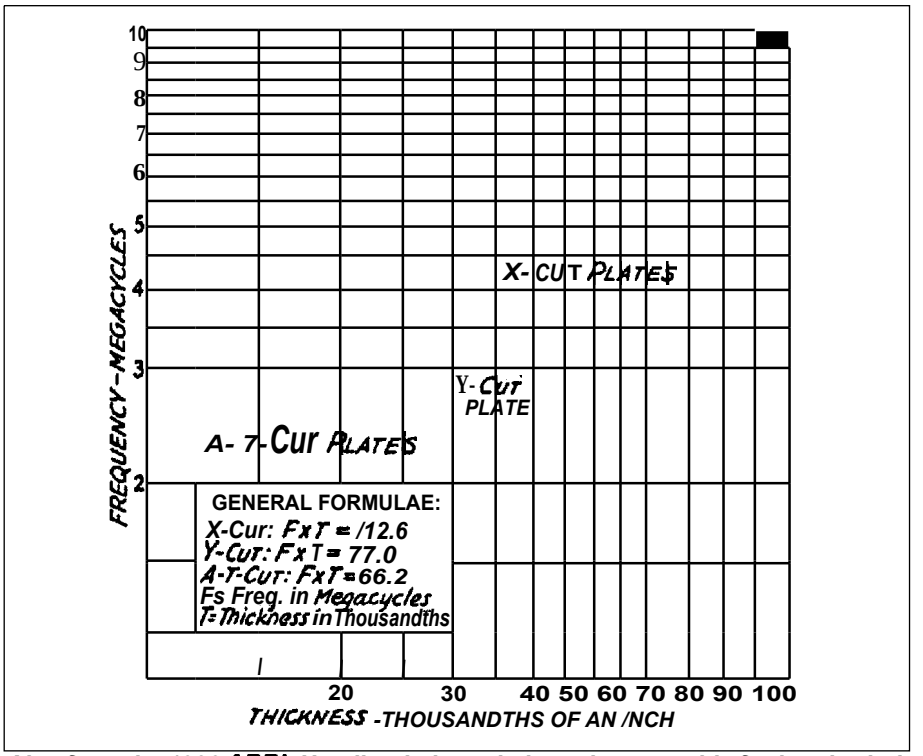
As mentioned in the last issue, one of the very early challenges to supply finished crystals on a semi-commercial basis came with a visit to his home by Alf Traeger and Dr John Flynn of the Royal Flying Doctor Service. The RFDS faced the problem of providing wireless communication with lonely cattle stations and outposts dotted over the vast interior of Australia. In the event of an emergency, there could be no assurance that such equipment had been maintained in the interim or that a knowledgeable person would be on call to operate it.

Alf Traeger, with the help of fellow amateurs like Wally Coxon, came up with a transceiver powered by a generator, driven by pedals in the manner of an exercise bike. Almost any one could provide the necessary energy — adult or child, male or female, black or white.

The first version of the transceiver operated on Morse code, which presented an obvious limitation. Traeger's initial response was to adapt a typewriter so that tapping out a message on the keyboard would cause the pedal transceiver to transmit the text in Morse characters. I quote from Max Howden's taped interview:

"The greatest step... was the designing and development of an automatic typewriter by Mr Traeger, by which laymen who did not know Morse at all could simply, by pressing the buttons on the typewriter, automatically send the Morse code replica... with the necessary spacing... so that an operator at the Base could copy it."

The reliance on Morse code was obviated when the Pedal Set was re-developed for telephony, making it possible to communicate by word of mouth. There remained, however, one major limitation: namely that of frequency stability. Transmitters throughout the system relied on conventional tuned L/C circuits, which could be moved off-channel by mishandling, temperature changes, or variations in the supply voltage — any one, or all three!



Also from the 1936 ARRL Handbook: intended purely as a guide for hand-grinding crystals, a plot of wafer thickness against frequency for X, Y and AT cuts.

The pedal sets posed a special problem in that the effective supply voltage depended on the inclinations of the person doing the pedalling. They might pedal fast or slowly, or an erratic mixture of both — with the RF oscillator following suit in terms of frequency. At best, the operator at the receiving station might have to keep nudging their tuning knob; at worst, they might miss the message completely.

To Alf Traeger, the answer to the problem lay in the emerging focus of the amateur fraternity on crystal control. The result, as already mentioned, was a personal visit by Alf Traeger and Dr Flynn to Maxwell Howden: "Would he undertake the manufacture of crystals to stabilise the frequency of up-dated pedal sets and other transmitters, that Mr Traeger would design for the Flying Doctor Service?"

This was his reply, as recorded on the interview tape:

"So I undertook it then and there — and have done it, along with other things, ever since."

At that point the transcript of the taped interview ended, leaving me to speculate what Max had meant by `along with other things'. In the temporary absence of John Howden, I managed to contact his brother Arthur ("call me Bill"). While acknowledging that John was the better informed about family history, 'Bill' confirmed that his Dad had never abandoned his amateur status, but had simply 'put on his commercial hat' to the extent that it became necessary, following his cornmittment to the RFDS.

(From W. Scott McPheat's book on John Flynn, I learned that by 1939 the number of pedal sets in use in the outback was about 150, mostly grouped in clusters around 'mother' stations. In those days, that would certainly have been enough to get Max started!)

Family business

Said Bill: "Dad had always operated from his home address. When his activities outgrew the space available in the house, he had built a workshop/factory in the backyard where he managed to accommodate new technology and rising demand."

At times, his 'staff' comprised mainly family members. During the war, the backyard factory housed people assigned to him by the Manpower Authorities, plus technical visitors from the various services.

In the early days, Bowden crystals were hand-ground and comprised a hor-

izontal metal platform on a spike, supporting the flat crystal wafer. Another metal plate rested on top of the crystal, with a flying lead for connection into circuit. These gave way to a more homogenous vertical assembly, with the crystal supported lightly between two metal plates in a shell measuring about 1-1/4 x 3/8 x 1-3/8 inches (D x W x H), with pins about 3/4" apart. Then came a scaled-down version with pins about 1/2" apart, and an even smaller and more rugged type around the time of WW2, commonly described as FT-243.

Questioned about technology, Arthur said that his father used plain old-fashioned hand-grinding to produce his earliest crystals using a slab of thick plate glass with coarse, then fine grain, carborundum powder. It was slow and tedious work.

Later, he invested in a lapping machine, in which a dozen or more slabs could be held in slots in a flexible spacer plate so that they would be ground down more or less uniformly. This done, the individual wafers would be hand-finished separately to the required frequency.

"Did he use acid etching?"

"He tried everything!"

"What about the technique of plating crystals, rather than mounting them between separate metal electrodes?"

"Plating? Well, Dad was certainly into the deposition of silver in a vacuum chamber. They would watch the resonance falling as the deposition progressed, and stop it at the right moment."

"That sounds as if he was using a digital frequency standard".

"He certainly was. Dad was well and truly into digital technology. He worked until he was in his mid '70s, and while he had younger people working for him, he was well up with what was going on. Dad may have become a professional, but he was still an amateur right up to the end!"

My thanks to John and 'Bill' Howden for their help in fleshing out the 'big picture' of their father's career.

A FINAL TRIBUTE

Amateur Radio magazine for October 1983 contained an article by Maxwell Hull VK3ZS, reminding readers that the issue represented the 60th anniversary of the magazine itself, as well as worldwide two-way communication by amateurs on the officially 'useless' shorter wavlengths.

It was also an appropriate time to recall the contribution of the late Walter Francis Maxwell Howden: Permit 19 - Permit V140 - 3BQ - A3BQ - OA4BQ - VK3BQ.

Then followed a summary of Max Howden's career and his very considerable contribution to the communications industry, and to the Amateur Movement in particular.

Featured was a drawing by L.F. Reynolds with the following caption:

'A curious man, with a face paled by long vigils and by eyes lighted by the fanaticism of one who had dedicated life to a passion. The techniques of wireless slip off his tongue as the prayers of a Buddhist monk, and I doubt if he has, in recent years, mentioned any other subject with animation. He had the strange gift of concentration on one thing, which marks men of high talent.

Vale Max Howden, VK3BQ, 18th May 1980.'

Personal memories

Finally, a personal word. I first became actively aware of Max Howden after the war, when expeditions to Prices Radio, ACE Radio and similar firms turned up oddments of war surplus equipment containing plug-in crystals, usually of the larger variety described earlier. Branded variously AWA, RCA and Howden, they had one thing in common: their marked frequency never coincided with an amateur band!

However the magazine's then Editor, the late John Moyle, taught me that the 'next best thing' was a reputable crystal ground for a frequency comfortably *below* an amateur band. Give him a free evening and a new record album to entertain his ears, and he'd move the resonance up into the adjacent amateur band...

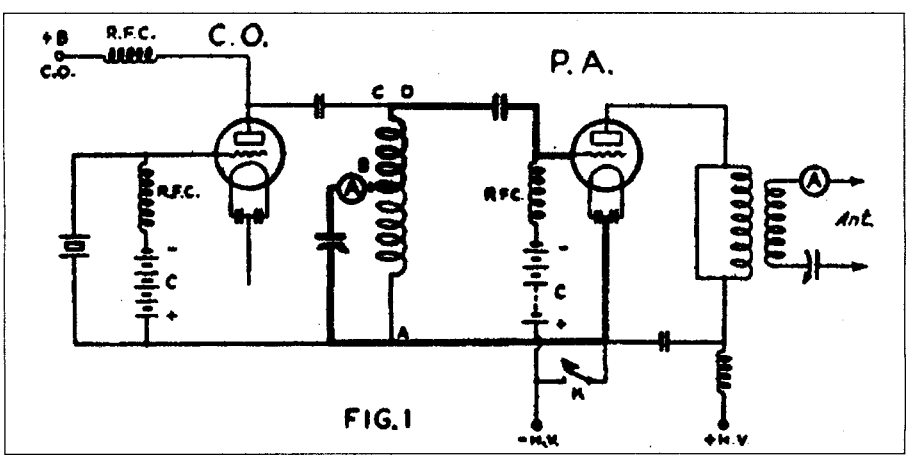
As it happened, John had picked up a military wavemeter using a simple battery powered type 30 triode, and a precision tuning capacitor and finely calibrated dial. Calibration involved listening for heterodynes with signals from commercial stations of known frequency, and plotting the dial readings in a graph book. By using harmonics as well as fundamental carriers, it was possible to pinpoint a wide range of frequencies.

John Moyle had also scored a handy lump of plate glass 1" thick, quantities of carborundum powder and hydrofluoric acid in a plastic container. My mental picture of relaxation at the time was John Moyle with all this set up on the dining room table, with a gas fire, a pipe and a classical album as interpreted by an Ortofon pickup, a Playmaster amplifier and twin Wharfedale loudspeakers...

It was little wonder that John Moyle was never short of a crystal, or that members of the *R,TV & H* staff rarely ground their own. Why would we, when John Moyle gained so much pleasure from guiding otherwise useless blanks to a new target frequency, with 'a rub here and a rub there' to optimise the activity...

During a recent sort-out of my career left-overs, I came across a transistorised crystal checker and an assortment of reference crystals that reminded me of the Howden era: 1MHz, 2MHz, 3MHz, and so on. They're mainly in the FT-243 package and huge by modern standards, but they were highly valued at the time.

Having summarised the life story of Max Howden, it is easier to understand his lifetime fascination for those crystalline slabs. What fascinates me nowadays is the number of crystals which regulate even the least expensive clocks and watches, with an order of accuracy measured in minutes per year! ❖



In OST for November 1929, Max Howden gave this circuit for a 'keep it simple' 3.5MHz transmitter involving a single common cathode 201A oscillator, plus a 210 power amp (as shown) or two 210's in parallel.