OTN

Old Timers' News

Journal of the ***Radio Amateurs Old Timers Club Australia Inc***

Number 62 September 2018

Contents

Radio Amateurs Old Timers Club Australia Inc

Established 1975 Incorporated 2002 Member of the WIA

Correspondence

Please note that all correspondence for the RAOTC and for *OTN Journal* is to be addressed to:

RAOTC
PO Box 107
Mentone VIC 3194
or by email to: ***raotc@raotc.org.au***

OTN Journal

***OTN* Journal is published twice yearly by RAOTC Australia Inc and is mailed to all members in March and September of each year.** ***OTN* is dependent upon material supplied by members and all contributions are most welcome,** particularly those describing your experiences in your early years of amateur radio communication.

RAOTC Office Bearers

President; Secretary; Broadcasts. Ian Godsil VK3JS, Tel: 0466 286 003

Vice President; Broadcasts. Bruce Bathols VK3UV

Treasurer Mike Goode VK3BDL, Tel: 03 9589 5797

Minute Secretary Jim Gordon VK3ZKK, Tel: 03 9893 1711

Membership Secretary; *OTN* Editor. Bill Roper VK3BR, Tel: 0416 177 027

Web page co-ordinator. Andy Walton VK3CAH, Tel: 03 9783 6859

Committee Members David Rosenfield VK3ADM, Tel: 03 9700 1225
Derek McNiel VK3XY, Tel: 0418 991 119
Anthony Rogers VK3JIA, Tel: 0447 747 213

RAOTC Membership and Fees

With the objectives to maintain the interest and original pioneer spirit of amateur radio, honour the history and heritage of our hobby, and encourage good fellowship amongst all radio amateurs, **Full membership** of the **RAOTC** is available to any person who has held, or has been qualified to hold, an Amateur Licence for a minimum of 25 years.

Associate membership is available to any person who has held, or has been qualified to hold, an Amateur Licence for a minimum of 10 years. Associate members are entitled to all the privileges of Full membership except the right to vote or to hold office.

Membership subscriptions, which fall due on 30th April each year, are: a $5.00 joining fee for new members (to cover the cost of a membership certificate, recording of membership, and initial postage); $18.00 for a one year membership; or $32.00 for a two year membership; or $375 for a Life membership.

An RAOTC member, on achieving 90 years of age and having been a member for a minimum of 10 years, automatically qualifies for a free Life membership.

The **address flysheet** accompanying your mailed copy of *OTN* journal shows your **RAOTC** membership number and your membership financial situation in a line immediately above your name and address. In addition, if your membership subscription is due, a reminder notice will appear below your name and address.

Application forms for membership of the **RAOTC** are available from the RAOTC, PO Box 107, Mentone VIC 3194 on receipt of a stamped self-addressed envelope, or on receipt of an email request to *raotc@raotc.org.au* or as a download from the RAOTC web page at *raotc.org.au*

Enquiries will be welcomed by President/Secretary Ian Godsil VK3JS on 0466 286 003; or by Membership Secretary Bill Roper VK3BR on 0416 177 027; or by email to *raotc@raotc.org.au*

RAOTC Broadcasts

VK3OTN, the offical callsign of the RAOTC, transmits news and information sessions for the benefit of members on the first Monday of each month (except January) at the following times and frequencies:

10.00 am	Victorian time (all year)	VK3REC on 147.175 MHz FM, plus 1.825 MHz AM, and 7.146 MHz LSB.
08.30 pm	Victorian time (all year)	3.650 MHz LSB.
		Interstate relays
10.00 am	WA time (all year)	VK6OTN on 7.088 MHz LSB and NewsWest FM repeaters.
01.00	UTC (all year)	14.150 MHz USB beaming **North-east** from Adelaide.
07.30 pm	Tasmanian time (all year)	via the VK7RAA network across northern Tasmania and the VK7RTC network in southern Tasmania.
08.30 pm	Local time (all year)	VK7AX Video Stream via BATC - *www.batc.tv/streams/7ax*

Check the RAOTC web site for any broadcast variations - call back sessions follow each transmission.

RAOTC web site: *www.raotc.org.au*

From the committee . . .

What value is a good committee? Is it necessary that all members of the committee be the right type of person for the committee?

The answer to these questions is yes, it is extremely important that each member of the committee be a contributing factor, not just someone to make up the numbers. I recall many years ago when I was the Secretary at one of the oldest radio clubs in Australia (established 1948) with a membership of 150. The club met in a room which was part of a municipal building; the building was to be demolished and there were no plans to house the radio club in the new building.

The committee of seven devised a plan to make the municipal council sit up and listen to our proposal. Each member of the committee was tasked to approach their local councillor to discuss the history of our club, amateur radio and its benefits, and the plan for a new clubroom.

As it happened, the Mayor of the municipality was my next door neighbour who was invited to inspect my shack and speak to another radio station.

Each member of the club's committee was experienced in their profession. There were accountants, bank managers, senior technical officers, public service administrators, builders, and an architect, just to name a few. The result of this combined effort by the committee is a beautiful building which stands today, designed and paid for by the municipality, the radio club, and three other contributors.

Without the combined effort of the committee and their expertise this project would not have come to fruition.

David Rosenfield VK3ADM
RAOTC member No 1622

ar

From the editor . . .

As usual, this edition of *OTN* contains a mix of articles covering a wide variety of subjects, mainly historical in nature and with at least some relationship to electronics.

Normally, I also publish articles more or less in the order in which I receive them from the various contributors. But this time I have made an exception.

Just a short time ago the attention of us all was fastened on the events happening in a limestone cave in Thailand. And the incredible rescue event where, ignoring politics, race and religion, people from many countries worked together to rescue 13 trapped Thai youngsters.

The world rejoiced when these youngsters were rescued but very few knew that the rescue efforts depended heavily upon a piece of equipment designed and built by a radio amateur. This amazing story is our lead article on page 7. Make sure you read it and feel proud that you are a member of the amateur radio fraternity.

Incidentally, it is pleasing to note from the many messages I receive from Club members that most avidly read each issue of *OTN* from cover to cover.

If you enjoy reading the journal so much, how about writing a contribution. I am always looking for more articles and letters, particularly of your own experiences in radio and electronics.

Another item which I always seem to be short of is suitable good quality, interesting photos, not only for the front cover but also as fillers for those odd spaces thoughout the journal.

A very big thank you to all those Club members who did contribute articles to this edition of *OTN* and to those who also contributed articles that I was unable to fit into this issue.

Articles received and prepared ready to be published in the next edition of *OTN* are from: Clive Wallis VK6CSW (1 filler, 5 articles); Herman Willemsen ex VK2IXV (5 articles); Lloyd Butler VK5BR (2 articles); Max Shooter VK6ZER (1 article); Will McGhie (1 article); and Bill Roper (1 article).

Apart from the material provided by the authors, much of the production and delivery of *OTN* is a one man effort. However, a very important part of the success of *OTN* is due to the efforts of Clive Wallis VK6CSW.

Not only does he provide a never ending source of interesting articles for publication, but he is also my 'go to' proof reader of each article after I have prepared it for publication. I have lost count of the times he has picked up my mistakes and made suggestions to improve the presentation of an article.

Interestingly, like so many of my very good 'on-air' friends of many years whom I have never met in person, so it is with Clive, although our close friendship has been forged, not 'on-air' but mostly via email.

Enjoy your reading of this edition of *OTN*.

Bill Roper VK3BR

ar

Editor
Bill Roper VK3BR
Typesetting and Layout
Bill Roper VK3BR
Article proof-reading
Clive Wallis VK6CSW

Printer
High Tech Printing Services P/L, Ballarat
Enveloping and addressing
Bill Roper VK3BR
Mailing
Mike Goode VK3BDL

Front Cover Photo

Mike Charteris VK4QS, RAOTC member No 1329 and ex RAN, in his shack. Mike is active in his local RSL and organising Naval commemorative events.

From our members ...

More on Sputnik

G'day Bill,

Your request in the last issue of *OTN* for stories about Sputnik reminded me that I had heard it when I was at school.

When I started high school, I met others interested in radio and constructed a number of crystal sets. I became interested in radio theory and borrowed *The ARRL Handbook* from the local library. I also sometimes worked for the local radio repairman as his valve jockey. If I was unable to get a radio going by changing valves, he would come into the workshop and using his usual test instruments - a screwdriver and a 3 Megohm resistor - find the faulty component and instruct me to change it. The screwdriver was used to test for high voltage at various points in the circuit and if that failed, he would bridge the 3 Megohm resistor across various resistors until he found the one which was open circuit.

I had the uncased chassis of a dual wave receiver which I used to listen to shortwave. When Sputnik was launched, I went outside at the advertised time and saw it going overhead. The next night, having heard that it was transmitting on 20 MHz, I tried to see if I could hear it. Although the receiver was only supposed to tune from 6 to 18 MHz I tuned it hard against the high frequency end and waited until the time of the satellite's pass. Lo and behold, I heard a beeping which became louder and louder. When I went outside, I saw the satellite overhead and then went back inside to hear it gradually get weaker and weaker.

A couple of years later I sat the amateur exam. As I lived at Latrobe, near the north coast of Tasmania, I did the exam one evening at the Devonport Post Office. I was the only candidate and the supervisor, after waiting half an hour while I did the regulations paper, started me on the much longer theory paper and then said "I'm just going over to the pub for a while" and disappeared. An hour later, he returned and said, "Jeez - have you written all that?". Then he gave me a can of beer and went back to the pub. He returned at the proper time to collect my completed paper.

I passed the exam and, as the proud owner of a Z call, I thought I should build some VHF equipment. So I built a 2 m super-regenerative receiver and mounted a three element Yagi on my mother's rotary clothes line. I pointed the antenna north hoping to receive stations in Melbourne. I heard nothing and had no idea why. Which just goes to show that passing an exam doesn't mean you know much. Yet.

73,
Ric Rogers VK7RO
RAOTC member No 908

Wireless Set A510

The photo of the WS-A510 on page 59 of the March 2018 edition of *OTN* brought back memories of when I was in the CMF back in the 1960s. We used them for communications on exercises.

I seem to recall that they were used with end-fed aerials but I'm not sure; however they worked quite well. The frequencies I recall were around the 80 m band with two different frequencies, one for the day and one for night. I never bothered to tune the aerial because the frequencies were too far apart and a lot of my mates could not understand why I did it. I must say that I had the Z call then.

I remember very well one night we were given a talk on the set and when I asked the question, "What is the power output?" the lecturer said, "One amp". I replied, "No, surely that's the battery current?" The lecturer was confused and didn't know what to say. Even the Sigs officer didn't know either. He was an electrician and knew nothing about radio theory or associated matters.

Initially I was with a Signals Squadron then transferred out of it and into a RAEME (Royal Australian Electrical and Mechanical Engineers) unit where I learned much more about motor mechanics, even though it was elementary information. They both provided a great combination of useful knowledge.

Merv Deakin VK4DV
RAOTC member No 1230

Radio ain't what she used to be!

Dear Bill,

Like Ron VK5VH (*OTN* March 2018, page 5), my interest in radio goes back a long way. I first became interested in the technical side of radio at the ripe old age of four. Our domestic radio needed attention, and I can remember the chassis being up-ended on the kitchen table and a neighbour (who was probably a relation) prodding about among pretty coloured things about two inches long. It was the colour that caught my eye, and I made up my mind there and then, that that was what I wanted to do when I grew up. I later found out the pretty coloured things were in fact body-end-dot type resistors.

In the mid 1940s, Adelaide changed from a 210 volt distribution system to a 240 volt system, and somehow we missed out on getting the 240/210 volt auto-transformer for the radio. Needless to say, the radio 'spat the dummy' a short time later. The replacement was a Schamberg Strauss console model, made and distributed in Adelaide by Ernest Smith & Co (later, trading as Ernsmiths).

This radio covered the short-wave bands as well as the broadcast band, and during the Second World War, I used to tune into the BBC and Radio Switzerland on a regular basis. One end of the short-wave dial was marked "40 Amateur", and when my father explained to me what it meant, I was hooked. Incidentally, the band-switch of this radio got a really good work-out and needed replacing after about two years, so I guess I did my first radio repair job at around the age of twelve.

Learning Morse was a challenge as the required speed at the time was 14 wpm. There was a plateau at around 10 wpm. on which I was stuck for about six months then, suddenly, I was up to 22 wpm virtually overnight. This was the difference between reading a letter at a time and a word at a time. At 22 wpm there was another plateau with the next jump being the difference between reading a word at a time and reading a phrase at a time.

After a nine month non-indentured 'apprentice-ship' on the infamous 288 MHz band, I sat for and

RAOTC QSO Party 2018

All licensed Australian Amateur Radio Operators are invited to participate in the annual QSO PARTY sponsored by the Radio Amateurs Old Timers Club Australia Inc.

This is not a contest, just an on-air meeting of RAOTC members and fellow amateurs.

However, we do invite you to submit a log of your contacts for listing on our web page.

Date: Saturday, 15th September 2018.

Time: 0600 - 0800 UTC.
4 - 6 pm Eastern; 3.30 - 5.30 pm Central; and 2 - 4 pm Western.

Object: To make as many contacts as possible, especially with members of the RAOTC. Repeat contacts in the second hour are encouraged.

Bands: 40 and 20 metres.

Modes: CW, AM and SSB.

Suggested frequencies:
40 m: CW 7020 kHz; SSB 7080 - 7110 kHz; AM 7120 kHz
20 m: CW 14040 kHz; SSB 14160 kHz - 14170 kHz; AM 14150 kHz

Calling: On CW "CQ OT". On **Phone** "CQ Old Timers".

Exchange: Callsigns and RST reports.

Scoring: One point per contact.
Add 25 points for using a radio 25 years or more old.

Logs: In order to acknowledge your participation, you are invited to send a log of your contacts, so that a list may be compiled for publication in the monthly broadcast, on the RAOTC web page and in *OTN*. Your list should show the name and postal address of the operator submitting the log, the number of contacts with callsign, RST exchanged, points claimed and whether you used a radio over 25 years old or not.

Send Logs to: Secretary, RAOTC, PO Box 107, Mentone, VIC 3194
or via email to *raotc@raotc.org.au* by Friday, 21st September 2018.
If sending by email and no acknowledgment is received, please resend.

Certificates: Certificates will be issued to:
- Scorer with highest total contacts;
- Highest scorer using an old rig; and
- Highest scorer in each mode in each hour.

Ian Godsil VK3JS

passed my AOCP in 1952, and was subsequently issued Experimental Licence number 8845, and the call-sign VK5QV. As Ron indicated, the exams in those days were 'real' exams not the multi-choice 'let's-have-a-guess' type exams of today. To become licensed in those days one also had to sign a Statuary Declaration of Secrecy which forbade one discussing or commenting on any material heard on the short wave bands. I often wonder whatever happened to all those Declarations of Secrecy?

While on the subject of exams, I sat for and obtained my 'broadcast ticket' (BOCP) in 1959. This consisted of two written exams - an electrical paper, and a radio paper. One also had to undergo an oral exam and a practical test. At the end, it gave one the qualifications to design, construct, install and maintain a broadcast station. We do our weekly shopping opposite the ABC transmitting site at Pimpala in Adelaide, and when I look up at the main antenna, I shake my head and say to myself, "Not any more old son".

I consider myself lucky that I have been involved with radio in the period in history that I have - close enough to its beginning to appreciate it, and long enough to see the technology evolve as it has. However, on reflection, I must say that radio, and amateur radio in particular, ain't what she used to be!

And I think in some ways, that's a great pity.

73,
Ivan Huser VK5QV
RAOTC member No 477

ar

Oops!

Lloyd Butler VK5BR has pointed out a couple of errors which appeared in his article *A history of Parafield Airport and its facilities* published in the **September 2017** edition of *OTN Journal*:

Page 15: In the lead paragraph, the article was first published in the December **2016** issue of Aviation Heritage, not 2012.

Page 19: The photo caption for the **VHF Transmitter BC625** is correct, but in the text immediately below it is incorrectly shown as 'Transmitters type BC624'.

You may like to pull out this back copy of *OTN* and make these corrections.

ar

Club membership

If you have a look at the Membership statistics on page 32 of this issue of *OTN* you will note that Club membership has again fallen slightly.

We need to keep membership numbers up in order to be able to keep membership fees at their current steady level.

When was the last time you recruited a new member to the RAOTC? How about helping your Club, and the Club management committee, and see if you can recruit a new member today!

RAOTC financial statements

Mike Goode VK3BDL
RAOTC member No 1610

Below are the RAOTC Financial Statements for the year ending 30th April 2018 with comparative figures for the preceding two years. This report was accepted by the RAOTC Management Committee at the meeting on 10th May 2018 and will be presented for approval at the Annual General Meeting to be held on 27th September 2018. If you have any queries about the results presented here, please do not hesitate to contact me.

Financial Statements

	Year to 30-Apr-2016	Year to 30-Apr-2017	Year to 30-Apr-2018
INCOME			
Sales: Badges	2.00	-	-
DVDs	220.00	339.00	280.00
CDs	5.00	-	-
Receipts from functions	2,484.00	2,880.00	2,916.00
Subscriptions	5,801.00	6,333.50	6,404.00
Donations	141.00	313.00	118.00
Interest received	623.40	665.62	847.72
TOTAL INCOME	**9,276.40**	**10,531.12**	**10,565.72**
EXPENSES			
Function expenses	2,233.92	2,626.03	2,463.10
DVD production	54.30	63.00	47.30
Insurance	373.02	414.94	460.22
Administrative costs	714.50	827.98	939.31
OTN printing, packaging & postage	4,628.33	5,028.91	4,973.11
TOTAL EXPENSES	**8,004.07**	**8,960.86**	**8,883.04**
SURPLUS / (DEFICIT)	**1,272.33**	**1,570.26**	**1,682.68**

BALANCE SHEET	**30-Apr-2016**	**30-Apr-2017**	**30-Apr-2018**
ASSETS			
Cheque Account	11,948.92	4,785.62	5,918.58
Term Deposit	20,000.00	30,000.00	30,000.00
Prepaid expense	550.00	250.00	-
Sundry debtors	-	-	74.00
TOTAL ASSETS	**32,498.92**	**35,035.62**	**35,992.58**
LIABILITIES			
Prepaid subscriptions	12,754.50	13,270.00	12,535.00
Account payable	-	450.94	460.22
TOTAL LIABILITIES	**12,754.50**	**13,720.94**	**12,995.22**
MEMBERS' FUNDS			
Opening balance	18,472.09	19,744.42	21,314.68
Surplus / (Deficit)	1,272.33	1,570.26	1,682.68
Closing balance	19,744.42	21,314.68	22,997.36
TOTAL MEMBERS' FUNDS & LIABILITIES	**32,498.92**	**35,035.62**	**35,992.58**

ar

Amateur-built HeyPhones used in Thai cave rescue

Clive Wallis VK6CSW
RAOTC member No 1289

***OTN* readers will surely remember the race against time in early July 2018 to rescue the 13 youngsters trapped deep in the Tham Luang Nang Non limestone cave in Chiang Rai province in Thailand. But they may not be aware that a very low frequency, single-sideband radio system designed and built by John Hey G3TDZ, and supplied by the Derbyshire Cave Rescue Organisation in England, played a vital role in bringing the rescue to a completely successful conclusion. Regrettably, John Hey died in 2016, unable to witness the part played by his HeyPhone in the worldwide coverage of this nail-biting event.**

On 23rd June 2018, after finishing football practice, 13 members of the Thai Wild Boars junior football team visited the Tham Luang cave located in a mountain range on the border between Thailand and Myanmar. Shortly afterwards, heavy rains partially flooded the cave, forcing the group to go deeper inside, eventually seeking refuge on a ledge some 4 km from the cave entrance.

After being missing for over a week, they were found by two British Cave Rescue Council divers on 2nd July and finally brought out safely between 8th and 10th July. The rescue operation involved an international team of specialist cave rescuers, including nine Australians subsequently awarded medals for their part in the rescue by the Australian government, supported by as many as 10,000 volunteers. Four HeyPhones helped to provide essential communications between the surface and the rescuers underground.

A full account of this incredible story can be found at: *https://en.wikipedia.org/wiki/Tham_Luang_cave_rescue*

Speleology, or pot-holing, is the science or sport of exploring and studying caves, often deep underground and many kilometres long. Obviously it is pitch dark and often involves diving through flooded sections. Accidents happen occasionally and rescues become necessary, but how can the rescuers communicate either with other teams or with the rescue coordinators?

Relaying messages by person is slow and may take hours in a difficult location; waterproof telephones involve laying lengthy wires which have the potential to entangle people and don't have the mobility of radios, yet shortwave radios won't work through water or rock. Is there an answer?

To quote from an article entitled *The HeyPhone to the Rescue*, by Mike Bedford G4AEE, published in the Radio Society of Great Britain's magazine *Radcom* in January 2002, "Cave rescue made a giant leap forward... when the Molefone was introduced in the early 1980s. Developed by Bob Mackin of Lancaster University, a member of the Cave Rescue Organisation in Clapham, North Yorkshire, it revolutionised cave rescue.

"Operating at a low frequency of 87 kHz in order to penetrate the rock and employing the principle of induction rather than radiation to avoid the need for huge antennas, the Molefone allowed underground rescue teams to talk directly to rescuers above ground.

"Operating in the inductive near field doesn't provide long range communication, as the signal strength decays with the cube of the distance. However, it does penetrate limestone to a depth of a few hundred metres which is perfectly adequate for most British caves. There are undoubtedly people walking around today who owe their survival to the Molefone."

Towards the end of the 1990s, the British Cave Rescue Council realised that although the Molefone had done sterling service it was coming to the end of its useful life. In conjunction with the Cave Radio and Electronics Group of the British Cave Research Association, a project team was formed to develop a new radio. Two key members were John Hey G3TDZ, who developed the electronics, and Brian Jopling, who undertook the mechanical design.

The HeyPhone transceiver is a single-channel, single sideband, waterproofed, battery powered voice radio operating at 87 kHz USB, designed to replace the older Molefone but still be compatible with it. It can operate with either loop or earth induction antennas.

Voice transmissions require an audio bandwidth of around 2.5 kHz for good clarity. To conserve battery power when transmitting, SSB is the preferred mode because it is more economical than continuous wave modes such as FM or AM. While a lower frequency might give better rock penetration, if the frequency is too low then speech modulation and bandwidth problems arise.

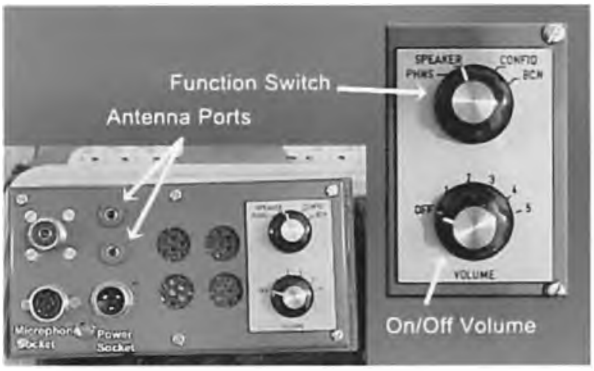
87 kHz USB provides a reasonable compromise and was probably chosen for the original Molefone because suitable crystals were available. Since the HeyPhone was designed as a second generation replacement for the Molefone and was required to be compatible with it, the same operating frequency was retained.

To survive the rugged environment of caving, a radio must:

- Be able to withstand severe mechanical shock;
- Have fully waterproofed electronics;
- Be immune from misuse by unskilled operators;
- Be highly reliable;
- Have long a battery life; and
- Be simple to maintain on site.

The HeyPhone meets all of these requirements. The transceiver consists of a two-part box; the bottom part contains most of the electronics - the transmitter board, receiver board and a control board - all totally sealed against water ingress, while the top part is the control box (see photo on next page) which contains the connectors for the external battery, loop and earth inductor antennas, microphone and earphones, as well as an internal loudspeaker plus the controls needed by the operator.

The two parts mate electrically via a waterproof 25-way plug and socket. The advantage here is that the damage-prone control box can be easily replaced on site by a relatively unskilled opèrator without disturbing the main transceiver electronics.



The HeyPhone control panel with an internal speaker between the connectors and the rotary controls.

The two user controls are both rotary switches, one for the combined on/off and volume control and the other for 'function'. The volume control switch is wired so that even at minimum volume the speaker audio is loud enough to attract attention so that no incoming calls are missed.

The function switch has four positions marked PHNS, SPEAKER, CONFID and BCN. Normally the switch will be set to the SPEAKER position, where the receiver output is connected to both the internal speaker and the mic socket. If it is set to PHNS, the internal speaker is disconnected, requiring a headphone/mic to be plugged into the mic socket. It is also possible to put the dynamic mic to the ear to hear incoming messages. PHNS is the only position which turns off the speaker.

The CONFID position causes the transceiver to emit a Confidence Beep every 30 seconds, so all other stations know the communications link is working. There is no way of sending Confidence Beeps with the speaker turned off. The BCN (Beacon) position makes the transceiver transmit beeps continuously; this can be useful while setting up a communications link and adjusting antennas.

The complete transceiver with essential accessories is transported in a high visibility, yellow Pelicase, a waterproof, shock-resistant casing designed for the job (see photo in next column).

It is one thing to design a radio but quite another to build it, especially in quantity. UK rescue teams wanted a total of 66 HeyPhones but having a commercial firm undertake the work was prohibitively expensive for these volunteer rescuer groups. As luck would have it, John Hey had just retired and nobly offered to build all the electronics himself. Populating nearly 200 PCBs is no light undertaking! Similarly, Brian Jopling undertook the mammoth task of making all the two-part enclosures for the radios out of heavy gauge PVC sheeting.

The official launch of the new radio took place on Sunday, 1st April 2001 at the British Cave Rescue Council's AGM at Ripley, Yorkshire, when it was named HeyPhone in recognition of John Hey G3TDZ's enormous contribution. At this meeting, many cave rescue teams took delivery of their new transceivers.

Little did anyone know that, 17 years later, four HeyPhones would play a vital part in a cave rescue televised worldwide.

While the foregoing outlines the use of HeyPhones in Thai cave rescue, you may wonder how do radio waves penetrate rock and why was the frequency of 87 kHz chosen?

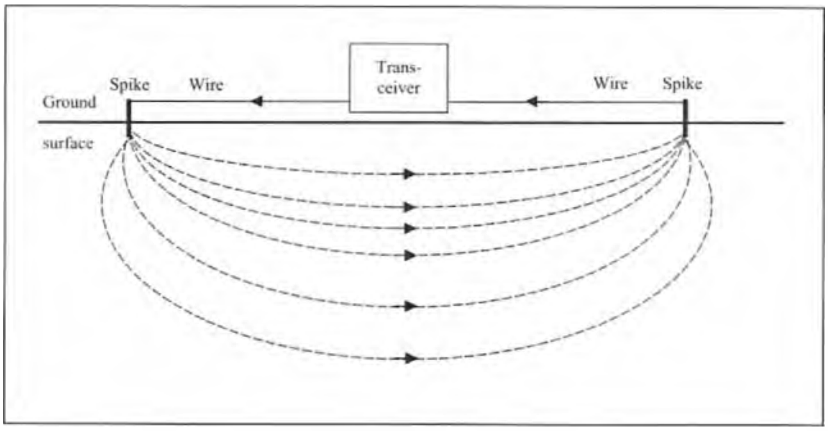
HeyPhone, battery, microphone, and earth antenna wire, etc, all packed in a waterproof Pelicase.

Heyphones use two modes of intercommunication; 'ordinary' radio waves via external loop antennas for short range work, or radio waves sent by ground induction using an 'earth induction antenna' for deeper ground penetration.

When radio signals strike the earth or water they do not instantly stop but penetrate it to a limited extent, about one wavelength, before being completely attenuated. It follows that the lower the frequency the longer the wavelength so the greater the penetration depth will be, but transmitted power and receiver sensitivity will obviously be major factors in the actual depth achieved. An example of this is the use of very low frequencies at very high powers for one-way communication with submerged submarines[1].

In the case of the HeyPhone, the frequency of 87 kHz equates to an RF wavelength of about 3.45 kilometres. However, because the speed of propagation of radio waves through rock is considerably slower than through space, the wavelength of the underground 87 kHz signal becomes shorter. This, coupled with the rapid attenuation of the signal and the low RF power output of the transmitter, restricts the useful range of the HeyPhone to a few hundreds of metres. Nevertheless, it has proven very adequate for surface to cave and intra-cave operations.

How is ground induction achieved? The following explanation is taken directly from the HeyPhone manual: "The antenna current from the transceiver flows out along one wire, into the earth at its outer end, back through the earth to the outer end of the other wire and back along the wire to the transceiver. It might be expected that the current in the earth would take the



Earth induction principle.

The HeyPhone's USB signal is generated by the phasing method (obviating the need for expensive crystal filters) and the receiver employs direct conversion demodulation. Thus both transmitter and receiver use a common carrier insertion oscillator frequency of 87 kHz, derived from an inexpensive 5568 kHz crystal divided down by 64.

The transmitter outputs about 5 W PEP and the low frequency allows use of a car radio audio amplifier IC (TDA2003) as the PA rather than a more expensive dedicated RF device. Indeed, all the components are standard 'off-the-shelf' items.

All up, the components for the 66 HeyPhones built by John Hey and Brian Jopling cost some £7,000 or around £106 per unit, far less than had the sets been built commercially. Had it not been for the dedication of these two men perhaps the HeyPhones would never have been built and perhaps the Thai cave rescue would have had a very different outcome.

Full details of the HeyPhone, including Technical and Operating manuals, circuit diagrams, pcb drawings, and parts list, etc, can be found at *http://bcra.org.uk/creg/heyphone/documentation.html*

shortest route between the two earth connections. In fact, it spreads out and takes a wide range of curved paths between the two earth connections; see the Figure above.

"The antenna operates as a one-turn coil of very large area. The actual effective area is not easy to calculate because portions of the current take different routes, as described above. Nevertheless, the further apart the earth connections are, the larger the effective area.

"The longer the wires the better the signal, though there may be a limit; this is not well understood yet. About ten metres per wire is currently thought to be a reasonable figure.

"The earth connections warrant care. On the surface, these are metal pegs pushed into the soil. All the current through the earth converges on these earth connections, which can cause problems: these two points can become bottlenecks which limit current and thus communication range.

"The important factor is the surface area of the connections in contact with the soil: this must be reasonably large. This is why the L-section Bulldog types are recommended: they have a large surface area in contact with the ground but a small cross-section, making them easy to push into the soil.

"The resistance in the soil is probably far greater than that in the metal, so there is probably no advantage in copper spikes, even though they are better conductors than steel.

"A single tent peg at each end may work for easy communication routes but not for hard ones. There are two approaches to increasing surface area: a longer rod or several short ones. A long rod is normally useless as the soil tends to be shallow. A reasonable arrangement is half a dozen of the L-section tent pegs joined together with wires. It is important that the pegs are separated by a bit more than their length, or their currents interfere with each other. This suggests connecting wires of about half a metre, allowing some room for manoeuvre to avoid stones and hard ground."

Where possible, a similar arrangement is made underground, but compromises may have to be made. Resonant loop antennas, usually about 1 metre square, suffice for shorter ranges.

Why 87 kHz? This frequency represents a reasonable compromise between ground penetration wavelength and the ability to voice modulate it at 2.6 kHz upper sideband without running into severe bandwidth problems. This was the frequency used by the Molefone and the HeyPhone had to be compatible.

John Hey G3TDZ working on a HeyPhone in his workshop.

Footnote

Around 2017, enthusiasts of the Shropshire Caving & Mining Club remodelled the HeyPhone using surface mount technology rather than the larger leaded components used previously and called it the µHeyphone (microHeyphone). Recently, experiments have been carried out with both the µHeyphone and HeyPhone using slow-scan TV to transmit photographs from underground to surface (and vice-versa) with the aid of a couple of free mobile phone apps to encode the images. Currently the images are restricted to 320 x 256 pixels by the apps - but it's a start! Possibly some of the hazy photos taken when the boys were first found came to us this way. Work is also proceeding on the development of a digital communications version of the HeyPhone.

Note

1. See my article Underwater Communications with Submarines, *OTN* No 49, March, 2012.

Principal references

• *https://en.wikipedia.org/wiki/Tham_Luang_cave_rescue*
• HeyPhone documentation: *http://bcra.org.uk/creg/heyphone/documentation.html*

ar

Powerships

Lloyd Butler VK5BR
RAOTC member No 1495

Where power grids around the world have been short on power capacity, the lease of mobile power stations fitted on large ships has been available to fill in the shortfall. Turkey based company Karadeniz Powership has numerous powerships which are carrying out this operation.

A powership is an exceptional marine vessel with an electrical generating station installed within. According to Wikipedia[2], powerships of various sorts and sizes have been around since 1931 for use where there are short term or urgent power needs.

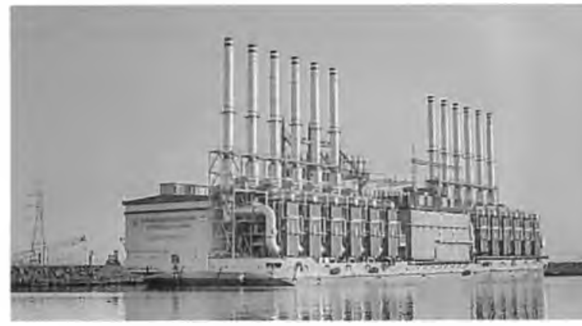
In 2009, the Karadeniz Powership, an auxiliary branch of the Turkey based Karadeniz Energy Group, took the initiative of developing its own powerships. They were expected to fulfil the urgent electricity requirements across the countries of the Middle East, Asia and Africa.

The current fleet has the capacity of producing more than 750 Mw of electricity with additional scheduled ships anticipated to increase total capacity beyond 2,000 Mw. They can be operated with either liquid fuels, natural gas, or liquid natural gas with an option for dual fuel.

The ship docks at a wharf and plugs directly into a high-voltage grid. There are six classes of powership, with capacities from 30 Mw to 470 Mw. One of these is the Turkish-built *Kaya Bey* with the large capacity of 220 Mw. Ships have on board a high-voltage substation and fuel storage.

It is claimed by the company that the floating power stations can be delivered in 90 days as a 'plug and play electricity solution', adding baseload power capacity and helping supplies for summer peaks. Leasing a powership for the short term can be a cheaper option than trying to erect quickly a shore based station.

Karadenez powership *Kaya Bey*.



Karadenez powership *Agsegul Sultan*.

The Istanbul based firm has installed barge or ship-mounted power plants in Ghana, Iraq, Lebanon, Indonesia, Zambia, and Mozambique. Wikipedia lists nine Karadeniz powerships at present in use. Other companies, previously with ships in use, have dropped out. However, Wikipedia also lists eighteen power barges. Another Karadeniz powership illustrated is the *Agsegul Sultan* with a capacity of 235 Mw. This one looks more like a barge than a ship. No doubt if it can propel itself under its own power it becomes a ship.

Leasing the powerships was one option available to the SA Government as a short to medium term solution to power shortage during the summer months. One plan was to anchor a 250 Mw floating power station at Outer Harbor and plug into a high-voltage grid near the 479 Mw Pelican Point plant.

A second option was for a 125 Mw powership at Outer Harbor, with another of the same size anchored off Port Augusta and plugged into the grid near the site of the defunct Northern Power Station. Had the option been taken up, it probably would have been operated from gas.

References

1. Powership - a hulking ship floated as a way to shore up power - *Advertiser* 17th June 2017.
2. Powership (history) - https://en.wikipedia.org/wiki/Powership

ar

Computer logging

These days we take computer logging of our amateur radio on-air contacts for granted. There are many freeware programs to choose from which offer logging software for the radio amateur and SWL, real-time and post-event QSO logging, log analysis and reporting, QSL label printing, country status display, rig control, import of logs, interface to CallBook CD-ROMs and so on.

When thumbing through the December 1988 edition of *Electronics Australia* recently I came across the following report in the New Products column.

Could this be the very first amateur radio computer logging program, in Australia at least?

Radio log program

Amateur radio operators can now save time logging their contacts on computer instead of the old longhand method. A recently introduced IBM PC compatible program, titled Logmaster, is one such program that adds power to a computerized shack.

Logmaster allows entry and tracking of all contacts using a simple menu driven screen. Once entered, there are a number of valuable functions available. Logmaster even handles duplicate logging to simplify contest scoring.

This handy, time saving program is available from Dick Smith stores for only $99.

I wonder if any Old Timers can remember using this program?

Clive Wallis VK6CSW
RAOTC member No 1289

It's as easy as ABC

Herman Willemsen ex-VK2IXV
RAOTC member No 1384

When I visited the Heritage Museum in Gerringong, NSW in May 2017, I came across a well preserved Wheatstone ABC electric pointer Telegraph. It was used in the 1860s on the 10 km long telegraph line from Gerringong to Kiama. These days ABC Telegraphs are rare items and, besides the one in the Telstra Museum at Bankstown, the Gerringong one is only the second one I have seen. My impressions about this relic of the past and its inventors are detailed below.

The first commercial electric telegraph was the culmination of many years of experimental designs by many researchers and innovators in America, England and mainland Europe. Amongst them were two Englishmen, Charles Wheatstone and William Cooke.

Who were these men?

The Wheatstone ABC electric pointer Telegraph on display at the Telstra Museum in Bankstown, NSW.

As a youngster Charles Wheatstone (1802-1875) was very studious. He devoured all types of books, amongst them the complete volume by the Italian pioneer Alessandro Volta about the discoveries in electricity. At age 14 he was apprenticed to his uncle, making and selling musical instruments. With his inquisitive and inventive nature Wheatstone soon started experimenting with acoustics, optics, electricity and the telegraph. His inventions were many[1] but he was best known for the 'improved Wheatstone bridge'. Before long he had made a name for himself.

At age 32 he was appointed professor of Experimental Philosophy at King's College London, but only lectured for one semester. For the remainder of his time at the College he busied himself with research only. It seemed that Wheatstone enjoyed the science, but had no great thought of commercialising it. He simply wanted to publish his innovations and allow others to freely make use of them.

After a five-year stint as an officer in the Indian Army, William Fothergille Cooke (1806-1879) studied anatomy and physiology in Paris, France and in Heidelberg, Germany. In 1836, in Heidelberg, he witnessed by chance a lecture and demonstration by the German physicist Georg Wilhelm Muncke of the Russian diplomat Baron Pavil Schilling's electrical telegraph, at a time when telegraph science was still only experimental and in its infancy. He was so impressed with its potential that he abandoned his medical studies and returned to England.

From then on his mission in life was to put the novel telegraph invention into practical operation with the British Railways, be successful and make lots of money. When he was unable to transmit his telegraph signals through wires longer than one mile (1.6 km), Cooke turned to Wheatstone for technical advice. They agreed to combine efforts to introduce the use of the telegraph on a large scale in England. Because of their opposing view-points, their collaboration was not a happy one. But this did not deter them from joining forces and establishing a formal partnership in 1837.

In this partnership Cooke handled the business side and Wheatstone provided his scientific guidance. In 1840, they patented the 'Wheatstone & Cooke ABC Telegraph', also called the 'ABC Pointer or Dial Telegraph'[2]. It basically worked like a rotary phone dial. As the operator rotated the alphabet wheel, electrical pulses were sent along the line which made the receiver's dial rotate in unison. For power it required a galvanic battery, also called a voltaic

A contemporary sketch of an 1858 model Wheatstone ABC Telegraph being used in a private household.

cell. It was awkward to operate and, as predicted by Cooke, failed to find a suitable market.

Wheatstone and Cooke continued to have an unhappy association and their working relationship became more and more strained. To make a long and complex story short, disputes over claims of credit for patent inventorship and patent ownership landed them in court and their partnership broke up in 1845. Wheatstone had kept the interest in 'his' 1840 electromagnetic dial telegraph alive and continued to further improve it. The result was an advanced model of the 1840 dial telegraph, which he patented in 1858 and called 'The Wheatstone ABC Telegraph'. It also became known as the 'Universal Telegraph'[3]. This is the model on display in the Gerringong museum and in the Telstra Bankstown museum.

Owing to its ease of operation, this advanced 1858 model became widely used on private lines or in situations where telegraph traffic was insufficient to justify the employment of a trained operator.

The advantages of the 1858 model 'ABC Telegraph' were affordability; robustness; simplicity to operate; no need for batteries; and no Morse code or 'Needle Telegraph' code had to be learned. Therefore, it was very popular with private companies, private households, merchant houses, banks, police departments, news agencies, small railway offices and small post offices.

Its disadvantages were slow speed[4]; only useful on low traffic and relatively short circuits; and it produced no printed record which meant that a person had to be present in 'real time' to write down the characters during reception.

The 'Wheatstone ABC' telegraph system consists of three main components:

1. A generator. This is a magneto device which produces a series of current pulses when the operator turns a handle projecting from the base.

2. A communicator (sender). It has a circular dial with a pointer. Marked around the periphery of the dial are 26 letters of the alphabet plus three punctuation marks and a cross (+) sign. Opposite those characters, around the edge, are 30 unmarked ivory keys.

3. An indicator (receiver). It has a dial on which the message is read. This face or dial is marked the same as the communicator's face, but it does not have keys as it is for receiving only. It also has an alarm bell to attract the attention of the receiving station before a message was sent.

The communicator and indicator were produced as stand-alone units or with both the communicator and indicator assembled on top of a mahogany box. The generator sat inside the box and was operated by a handle projecting through the front end of the box.

How to manipulate a 'Wheatstone ABC Telegraph'[5]

Before sending a message, the pointer of the communicator and indicator of all instruments should point to the cross +. This ensures that the sender and receiver are properly synchronised. To transmit letters step-by-step, the handle which causes the armature of the magnet to rotate should be kept in continuous motion by one hand, while a finger of the other hand is employed to manipulate the keys. A number of pulses corresponding to the selected letter are transmitted over the telegraph landline to the indicator of the receiving station where the needle rotates to indicate the received letter.

As well as letters, it is also possible to transmit numbers and punctuation marks. Easy to follow Post Office instructions were on hand[6].

In 1860 the South Australian Railways bought 52 sets of the Universal Telegraph apparatus. In Victoria the Wheatstone ABC Telegraphs were not only used between Government departments in Melbourne but also by smaller Post and Telegraph offices with light telegraph traffic, such as on the 40 km Melbourne to Whittlesea, the 15 km Melbourne to Heidelberg and the 32 km Melbourne to Kangaroo Ground landlines. In 1890 the Wheatstone ABC Telegraphs on all these lines were replaced by telephone channels.

By the way, in 1920, about 1,500 ABC pointer Telegraphs were still in operation in London alone, and on the remote isle of Eriskay, Outer Hebrides, Scotland, the ABC pointer Telegraph was still in use in the late 1930s.

Footnotes

1. Amongst his many inventions and achievements are two musical instruments, an improved dynamo, a rheostat, the improved Wheatstone bridge, a magnetic clock, a stereoscope and the Playfair cipher (an encryption technique).
2. It was their second English patent, as in 1837 they'd patented the 'Cooke and Wheatstone Needle Telegraph', which was highly successful on busy British Railway lines. It was also widely used by railroads in France and Belgium.
3. The name 'Universal Telegraph' was chosen carefully by Wheatstone, because it was supposed to be used by ordinary people in their offices, workplaces and homes. See the article in *Trove* at: http://trove.nla.gov.au/newspaper/article/13053424
4. Speeds of about 15 words per minute were possible.
5. To see it work, see YouTube at: https://www.youtube.com/watch?v=ltFgaYdjsuk
6. Google: History of Telegraphy - Ken Beauchamp - Google books. Go to: Review this book. Then go to p43 to see the PO Telegraphs Instructions for working Wheatstone's instruments.

Acknowledgements

The World Wide Web; Heritage Society Museum Gerringong NSW; Garry Murdoch, Tech Support, Telstra Museum, Bankstown.

ar

Cold cathode emission

Clive Wallis VK6CSW
RAOTC member No 1289

Although Karl Ferdinand Braun is credited with building the first cathode ray tube and cathode ray oscilloscope in 1897, I think it is fair to say that, as with so many things, it was a development of earlier technology rather than an outright invention. Just as Sir Isaac Newton famously quoted, "If I have seen further than others, it is by standing upon the shoulders of giants", so Braun saw the possibilities of developing the Crooke's tube, itself a development of the Geissler tube, into a device to visualise electrical signals. All these devices had cold cathodes.

These days when we think of cathodes emitting electrons we probably envisage either a hot wire filament or an indirectly heated oxide coated cathode, both of which are intended to supply copious quantities of electrons to make a vacuum valve, CRT or similar electronic device work. However, until the early 1900s all cathode ray tubes and X-ray tubes relied on cold cathode emission. The physics of cold cathode emission is complex but the following is an attempt to outline some (but by no means all) of the significant events leading to its discovery and then to give a simplified explanation of how cold cathode emission arises.

The story begins with the invention of the vacuum pump in 1654 which allowed physicists to experiment with passing high voltage electrostatic charges through rarefied air. In 1705, it was observed that sparks from such discharges travelled further through the low pressure air within a partially evacuated glass vessel than through normal atmospheric pressure.

In 1838, Michael Faraday found that when a current at high voltage was passed through a glass tube containing air that was even more rarified, but nowhere near a complete vacuum, a mysterious glowing light formed between the electrodes at either end of the tube, beginning at the negative (cathode) electrode and arcing towards the positive (anodic) one. He also observed that there was a small dark area between the cathode and the start of the glow. It would take over half a century to find the explanation.

In 1857, the German instrument maker, prize-winning glassblower and physicist Heinrich Geissler invented an early type of gas discharge tube which was able to demonstrate an electrical glow discharge that filled the glass tube, a technique still used in neon, sodium, mercury vapour and other types of fluorescent lighting. Geissler's tube consisted of a sealed, partially evacuated glass cylinder with metal electrodes at either end (see Figure 1 below).

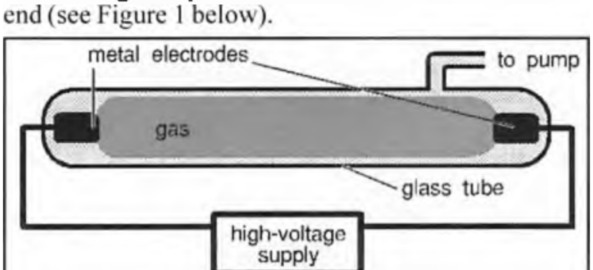


Fig 1. Gas discharge tube principle.

Using a hand-cranked mercury pump designed and built by himself, Geissler achieved much higher vacuums than did Faraday. With the application of high voltages from a Ruhmkorff (induction) coil, a small current flowed between the electrodes and, rather than just an arc, created a glow which filled the tube. The intriguing thing was that the current flow and glow in the tube only began when the pressure was reduced very significantly. At normal atmospheric pressure the air behaved as an insulator.

Geissler experimented with other gases which gave off glows of different colours, experiments which earned him the title of the 'father of fluorescent lighting'. Although the cause of the glow was not understood at that time, large numbers of Geissler tubes in all sorts of shapes, sizes and colours were mass produced from the 1880s as novelty and entertainment devices[1] (see Figure 2 below).

Fig 2. The centre globe of this Geissler tube is made from uranium glass and glows green under discharge.

Simple straight Geissler tubes were used in the latter part of the 19th century as high voltage indicators, and it was also discovered that when a Geissler tube was brought near a source of high voltage alternating current, such as a Tesla coil or Ruhmkorff coil, it would light up even without contact with the circuit. Such Geissler tubes were often used to tune to resonance the tank circuits of early radio transmitters, something many *OTN* readers have probably done themselves with a modern fluorescent light tube or neon bulb to show RF in a transmitter tank coil or voltage nodes on antennas and feedlines, much as Lecher did over a century ago[2].

In 1865, the German chemist Hermann Sprengel devised an even better pump which used the weight of mercury to create a vacuum and which was a huge advance on previous pumps; much lower pressures were now attainable.

By the 1870s an improved Sprengel pump allowed English physicist William Crookes (among many other researchers into gases and electricity) to be able to evacuate his tubes to a far lower pressure than Geissler had achieved. Pressures as low as a few millionths of an atmosphere were now achievable, but still not a complete vacuum[3].

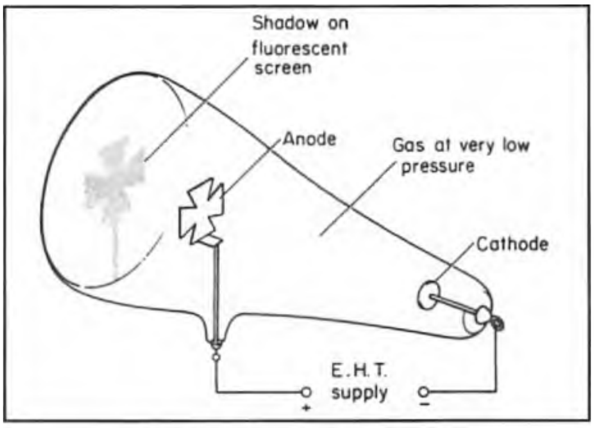


Diagram of a Crookes tube.

Crookes found that as he pumped more air out of his tubes, a dark area in the glowing gas formed next to the cathode, as Faraday had seen earlier. As the pressure was further reduced by the much more efficient pump, this dark area spread down the tube towards the anode until the inside of the tube was totally dark. However, the glass envelope of the tube now began to glow at the anode end. Why this was so and what was allowing an electric current to flow through the highly rarified gas remained inexplicable. Crookes also noticed that whatever these rays were, they could be bent by a magnetic field, indicating that they were some type of particle rather than a wave.

Crookes tubes came in many shapes and sizes[4]. Other researchers noticed that if the anode was located between the cathode and the far end of the tube a sharp outline of the anode could be observed on the tube's glowing end (see Figure 3 below).

Fig 3. Crookes tube with a shadow of the anode on the glowing glass.

At about this time the German physicist Johann Wilhelm Hittorf was also conducting experiments with a Crookes tube when he realised that the glow was caused by some type of ray travelling in straight lines through the tube from the cathode because the shadowed area was an exact replica of the obstruction created by the anode.

By 1876, another German physicist, Eugen Goldstein, proved that the glow was being caused by a new kind of radiation that started at the negative electrode and radiated across the vacuum until it hit the glass. Because Faraday, from his earlier investigations into electrolysis, had called the negative pole or plate the cathode, Goldstein called this radiation Kathodenstrahlen, or cathode radiation, although its exact origin and composition was still undetermined.

In 1894, Joseph John Thomson, Professor of Experimental Physics at the Cambridge University's Cavendish Laboratory, began studying cathode rays in great detail. This was a popular topic among scientists at the time because, although the rays were widely demonstrated in various versions of Crookes tubes and could be deviated by both magnetic and electric fields, their nature was still a mystery. Ultimately, Thompson would discover the true nature of the rays, a discovery which revolutionised atomic theory and which earned him the 1906 Nobel Prize for Physics.

In 1895, Wilhelm Konrad Roentgen was studying high voltage discharges in a large Crooke's tube when he noticed that a screen coated with a phosphorescent material, barium platinocyanide, lying several feet away was glowing. He realized that this glow was caused by some unknown radiation which must have come from the tube. He experimented further and discovered that this radiation could pass completely through some solids such as paper and wood, but denser materials such as lead, stopped them entirely. When he placed his hand between the tube and a piece of cardboard coated with barium platinocyanide and clearly saw the outlines of its bones, he realised the new radiation held great promise for medicine. He had taken the first X-ray of the hand.

In 1897, Karl Ferdinand Braun built the first oscilloscope enabling, for the first time, a visual representation of electrical signals to be made.

An original Braun CRT. Note cold cathode at right hand end, anode to right of support and collimator to left. Deflection coils not shown.

The common factor in all of these events was cold cathode emission.

What was happening inside these various tubes and how can cold metal emit electrons? A complete answer is complex and beyond the scope of this article, and while the following may not satisfy everyone, I hope it will suffice for most of us:

Imagine we have a gas at low pressure within a sealed glass tube with internal metal electrodes at either end, much as in Figure 1. The majority of the gas molecules will have no electric charge. However, ever-present natural background radiation due to cosmic and gamma rays will ensure that at least a few of the molecules are ionised, i.e. dissociated into a positively charged ion and an electron of equal negative charge. If a sufficiently high voltage is now applied to the electrodes, the electrons will be accelerated towards the anode and the ions towards the cathode, causing a small current to flow. Many of the accelerating electrons inevitably collide with molecules, some with sufficient energy to knock electrons from the molecules thus creating more ions and electrons, setting up a chain reaction known as a Townsend avalanche, increasing the current.

When the positive ions, which are much heavier than electrons, strike the cathode they do so with sufficient force to knock electrons out the cathode. Cold cathodes are usually made out of a metal such as aluminium which can emit electrons at a rate greater than unity, i.e. one ion strike can release more than one electron. These electrons join with the other electrons and accelerate towards the anode.

At this point we have a mixture of electrons, ions and molecules in the gas. If the voltage is high enough, many of the electrons will accelerate towards the anode, gaining kinetic energy. Some will ionise the gas molecules as mentioned earlier, but others may excite the molecule to a high energy state by transferring their energy to an electron in the outer orbit of the gas molecule, forcing that electron from its 'ground state' to an excited or high energy state, travelling in a higher orbit. The excited gas molecule is unstable and cannot remain in its high-energy state for long.

As the electron returns to its normal orbit (ground state), the excess energy is emitted as light. This is the source of the glow of a discharge tube. Because atoms and molecules can exist only in certain specific energy states, the energy emitted by the excited molecule is limited to the difference between these states. Only certain energies of light are emitted; the colour of the glow is determined by the energy of the emitted light, different gases producing different colours.

In the Geissler tube the gas pressure was about $1/1000^{th}$ of an atmosphere. The density of the gas molecules was too high to allow the electrons to gain much speed without incurring a molecular collision, simply forming a fluorescent glow which diffused through the gas. There were no cathode rays as such. The colour of the light emitted was characteristic of the gas or other ionisable material within the tube; hydrogen (red), helium (yellow), carbon dioxide (white), mercury (blue), etc. Thus many different colours and lighting effects could be achieved, laying the foundations for today's fluorescent lighting.

The first Crookes tubes were similar to a large, straight Geissler tube with the cathode and anode fitted inside the tube a short distance from each end. As we saw earlier, when Crookes was able to reduce the vacuum with the improved Sprengel pump, he found that as he pumped more air out of his tubes, a dark area in the glowing gas formed next to the cathode, much as Faraday had observed some 30 years earlier.

As the pressure got lower, the dark area, now known as the Crookes dark space, spread down the tube until the inside of the tube was quite dark. Curiously, the glass envelope of the tube now began to glow beyond the anode end, but why?

Gas pressure is directly related to its density, i.e. the number of molecules per unit volume. As the pressure was reduced there were fewer gas molecules to obstruct the passage of the electrons from the cathode so, on average, they could travel a longer distance before they struck one. The strong electric field, due to the high voltage applied between cathode and anode, accelerated the electrons thus increasing their kinetic energy.

By the time the whole inside of the tube became dark, at a pressure of a few millionths of an atmosphere, these invisible 'rays' were able to travel in straight lines from the cathode to the anode without a collision. When they reached the anode end of the tube, the electrons were going so fast, around 20% of the speed of light, and had so much kinetic energy, that many flew past the anode and hit the end of the glass tube.

On striking the glass, these invisible electrons excited the atoms in the glass, making them fluoresce with a faint greenish glow. Later, experimenters painted the back wall of Crookes tubes with fluorescent paint which converted the radiation to visible light, making the fluorescing area more visible.

Crookes tubes were temperamental and needed just the right amount of gas pressure and voltage to work properly. The cold cathode ray can only work if enough gas molecules are present to initiate the ionising process, but sufficiently widely spaced to avoid impeding the path of too many electrons. If just the right conditions prevail, the cathode ray stream (and the positively charged ion stream or 'canal ray') is self-sustaining. If the gas in the tube is rarified too much, the cathode ray production will reduce and eventually cease.

Conversely, if the voltage and current are allowed to increase too far, the positive ion bombardment can be so intense that it removes whole atoms from the cathode in a process known as sputtering, effectively an evaporation of the cathodic material. Electrons, however, have only a tiny fraction of the weight of ions and on striking the metal of the anode do not erode it.

In the 1880s, Dalton's atomic theory prevailed. This theory proposed that all matter was composed of atoms; indivisible and indestructible building blocks. While all atoms of an element were identical, different elements had atoms of differing size and mass, but this idea was about to change. As mentioned earlier, in 1894 Joseph John Thomson, Professor of Experimental Physics at Cambridge University's Cavendish Laboratory, began studying cathode rays in great detail, using better equipment and methods than previously.

J J Thomson's cathode ray tube.

Two significant improvements to Thomson's tube were the placement of the anode about a quarter of the way down the tube, followed by a collimator which concentrated the cathode rays to a small dot on the fluorescent screen.

When he passed the rays through the highly rarified gas vacuum, he was able to measure the angle that they were deflected by a magnetic field of known strength and, shortly thereafter, by a known electric field (see Figure 4 on next page).

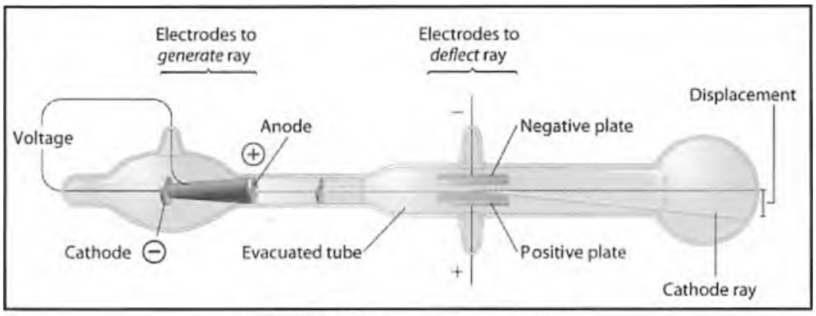


Fig 4. Thomson's experiment.

His experiments suggested that not only were cathode rays over 1,000 times lighter than the hydrogen atom, the lightest atom known to exist, but also that their mass was the same no matter which type of atom they came from. He concluded that the rays were composed of very light, negatively charged particles which were a universal building block of atoms. He originally called these particles 'corpuscles,' but later scientists preferred the name 'electron'. He hypothesised that atoms were divisible, and that the corpuscles were their building blocks.

In 1904, Thomson proposed a model of the atom, surmising that it was a sphere of positive matter within which electrostatic forces determined the positioning of the corpuscles. To explain the overall neutral charge of the atom, he proposed that the corpuscles were distributed in a uniform sea of positive charge, rather like fruit in a plum pudding. In recognition of his outstanding work proving the existence of the electron and theorising on the innermost structure of atoms, thereby laying the foundations of modern atomic theory, Joseph John Thomson was awarded the 1906 Nobel Prize for Physics. Two years later he was knighted.

Although Roentgen discovered X-rays when experimenting with a type of Crookes tube, X-rays are not cathode rays but are a very energetic form of electromagnetic radiation having extremely short wavelengths and far greater penetrating power than an electron beam, yet they rely on cathode rays for their production. Essentially, when a high intensity electron beam strikes an anode of suitable material such as tungsten and is immediately stopped in its tracks, its kinetic energy is converted to X-rays through a process called *bremsstrahlung*, literally 'brake radiation' (see Figure 5 below).

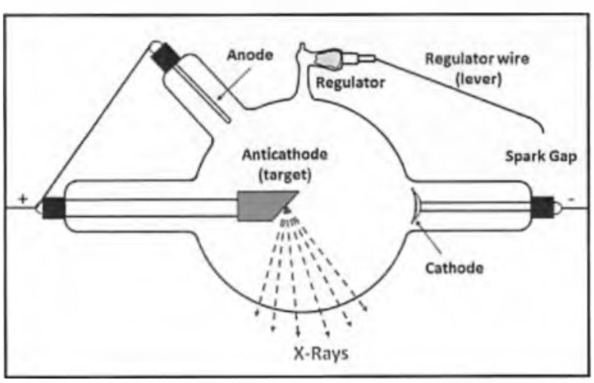


Fig 5. Principle of early cold cathode X-ray tube.

Until the invention of the Coolidge X-ray tube in 1913 which used a heated cathode, all X-rays were generated by cold cathode tubes and indeed many X-ray machines up until the 1920s and 30s still used cold cathode technology. Gas pressure and voltage were critical to obtaining good photographic images; tubes were fitted with gas pressure regulators to ensure that just the right amount of gas was present to sustain electron production at the required level. As we all know, X-ray technology revolutionised medicine - but that's another story.

Although now long gone from X-ray tubes, CRTs and most electronic valves, cold cathode technology is still widely used in sodium and mercury vapour street lighting and other types of fluorescent lighting, including background lighting for LED TV and computer screens, neon lighting, compact fluorescent lights, stroboscopic flashing lights on aircraft and nautical obstruction markers, etc. Many *OTN* readers will also recall devices like Nixie tubes, Dekatrons, gas filled voltage regulators and thyratons, all of which had cold cathodes.

Thermionic (heated cathode) travelling wave tube (TWT) RF amplifiers with operating frequencies range from 300 MHz to 50 GHz, and with power outputs up to the megawatt region, have for many years been widely used as the oscillators and power amplifiers in radar systems, communications and television satellites, spacecraft transmitters, and even electronic warfare systems. However, the power required for the cathode heater is significant.

Ongoing research into a new and potentially revolutionary kind of TWT - the ultra-compact and ultra-efficient cold-cathode travelling wave tube - looks set to offer significant improvements to these technologies, giving much higher RF output for a given DC input.

Perhaps for cold-cathode technology, the wheel has now come full circle!

Notes

1. See also *William John Hancock - First Superintendent of Telephones and Telegraphs, Perth* by Bill Toussaint VK6LT, *OTN* No 59, March 2017.

2. Many older amateurs will be aware of Lecher lines, invented by Austrian physicist Ernst Lecher in 1888, and their use to determine VHF and UHF wavelengths, although in fact a similar technique was used by Oliver Lodge and Heinrich Hertz at about the same time. By sliding a conductive bar that bridges two wires along their length, the length of the RF waves can be physically measured by seeking either current or voltage nodes and noting the distance between them.

3. Mechanical pumps cannot create a true vacuum. During modern valve manufacture, a deposit of reactive material known as a 'getter' is placed inside the glass shell. After the shell is evacuated and sealed, an induction heater evaporates the 'getter' material which condenses on the glass. This removes any remaining gas molecules together with any gas that may form during the valve's lifetime, thus completing and maintaining the vacuum.

4. An interesting selection of Geissler, Crookes tubes, CRTs and related devices can be found by Googling 'The Cathode Ray Tube site' *http://www.crtsite.com/page3.html*

ar

Cannonballs and fishing lures

Herman Willemsen ex-VK2IXV
RAOTC member No 1384

A cannonball can be many things. It can be a round stone or iron projectile fired from a cannon; the name of a locomotive in the 1957 American TV series *Casey Jones*; a flat serve in tennis; or even a jump into the water made with arms grasping the upraised knees. But none of the above meanings apply to my cannonball, a pair of headphones, the Cannon-Ball Master to be precise, made in the 1940s.

The earphones have an impedance of 2,000 ohms or 1,000 ohms for each earpiece. For more technical information on headphones see my story *Headphones, history and headaches* in *OTN* No 55 of March 2015.

Cannon-Ball headphones were made by The Cannon & Miller Company, located in Springwater, New York, USA. Their trade name was CAMCO and their marketing name Cannon-Ball.

They made the Cannon-Ball headphone models Alnico Magnetic No 15, Dixie, Empire, Junior, Master, President, Scout and The Chief.

Why the name of CANNON-BALL for a pair of headphones?

The type name of my Cannon-Ball Master headphones is engraved on the back of the earpieces together with the name of the manufacturing company.

I could not find any information on the origin of the name and therefore can only speculate. Cannon and Miller produced their first headphones only a few years after WWI. At that time people were buying up a lot of military surplus gear and were generally impressed by anything with Army or Navy connotations. The name probably also reminded the buyer of the 'Cannonball Express', the name of an express train of the time. In other words, the name 'Cannonball' just sounded kind of military, strong, fast and high powered, and of course it was the logical extension of the company's family name of Cannon.

It all started when Charles Cannon and Edmund Miller became acquainted when they both were

Edmund J Miller, circa 1916.

employees of the Buffalo Telephone Company in Buffalo. Cannon was the Treasurer of the company and Miller was employed as an Engineer and Draftsman.

Buffalo, New York, lies 32 km south-east from Niagara Falls, just south of the border between Canada and the USA. When discussing the possibility of forming their own company, Miller, who understood the construction of the telephone receiver, pointed out that there was very little difference between the active parts of a telephone receiver and the proposed earphones.

Once the decision to form their own company was made, a suitable place had to be found to start the manufacture of their product. Cannon suggested that the ideal place would be a small township with an available workshop where the rents would be low. They chose Springwater, a town in Livingston County, New York State. Its population was then, and still is now, around the 2,000 mark. They were in luck, as Springwater had a vacant mill which they were able to hire for only $5 per month.

So, on 23rd August 1919, the Cannon and Miller families travelled by bus 150 km in a south-westerly direction from Buffalo to Springwater.

A Springwater farmer, who had just sold his truckload of sheep on the Buffalo market, was happy to load the household goods of both the Cannons and the Millers onto his double-decker sheep hauling truck on his return trip to Springwater.

Two months later, the two newcomers in town began the manufacture of headphones in the old mill. Ten years later, in 1929, the Cannon-Miller partnership was dissolved when Miller sold out to Cannon to start the manufacture of metal fishing lures in another shed in Springwater. Edmund Miller and his wife Martha Ethel continued to make fishing lures for thirty years. In 1958 they sold their successful business and retired.

The Miller Fishing Lure Company in 1937.

A famous Miller fishing lure.

In the early 1940s, soon after amalgamating with the Chester Brandes Company, C F Cannon started making headphones with metal headbands instead of the cloth padded ones. Also, the plastic ear caps were made with small listening holes (seven in each earpiece of my Cannon-Ball Master) instead of the one central hole. The magnets inside the earpieces were also changed from the flat curved shape to a tubular curved shape. A form of economising, I assume.

Cannon products were made for another decade, well into the 1950s. I don't know exactly when, but J H Ambrose, using the company name JACO, bought out Cannon at some point. JACO made several models of

The Connon Miller Company of Springwater, New York and employees in 1939. Mr Charles Cannon is seated in the centre of the front row.

The author's Cannon-Ball Master headphones.

headphones, like the 'The Chief' (2,000 ohms) and another pair branded 'JACO'.

What is known is that in 2001, JACO, located in Canandaigua, New York was still in operation. However,

A close look at the components of an earpiece of the Cannon-Ball Master headphones.

when Mr Ambrose passed away in the early 2000s, the company closed its doors.

Nowadays there are no manufacturers of high impedance magnetic diaphragm headphones left in the US. However, whilst surfing the world wide web, I noticed that one radio outlet in the USA sells Chinese-made 'new-old' stock of high impedance military headphones of 2,000 ohms impedance.

The above described headphones were once the tools of trade of wireless operators ashore, on ships and on aircraft. Also, in the early 1920s, headphones were used by the public whilst listening to their radio at home. Now they are merely a thing of the past and valued mainly by collectors. **ar**

The nuclear women of Paris and Vienna

Bill Toussaint VK6LT
RAOTC member No 1561

The end of the nineteenth century and the beginning of the twentieth century were historic times when scientific theory was coming together to produce practical outcomes from which everyone could benefit. It was the time when radio waves were being transmitted and received over vast distances. It was also the time when there was much speculation about the nature of matter and the concept of the atom was openly discussed both in universities and in coffee shops by scientists.

It was a time of the unrestricted flow of ideas between scientists of all nationalities. This free exchange continued until the late 1930s when the realisation that the splitting of the atom and chain reaction (and subsequent energy release) could cause devastation to a population.

International cooperation then ceased and, with respect to nuclear physics, the concept of 'Top Secret' emerged.

While the scientists worked towards nuclear fission and hence the concept of the nuclear bomb, three women who were important in laying the groundwork for this discovery underwent their own personal tragedies. These women were Marie Curie, her daughter Irène Joliot-Curie and Lise Meitner.

Marie Curie

Before the dawn of the twentieth century the time was right for many exciting 'discoveries' (associated with physics and chemistry) to come to fruition. This influenced the decision of Marie Sklodowska to leave Poland and go to Paris for further studies relating to the nature of matter.

She was born Marie Sklodowska in Warsaw in 1867. At the time higher education was difficult or impossible for women in Poland. Her parents were very supportive but were of limited financial means. Such was the dedication of Marie that she and her sister Bronya worked out a solution to the problem: Marie would stay in Poland to work and earn money to support Bronya's study of medicine at the Sorbonne while later, when Bronya qualified, she would reciprocate and allow Marie to study in Paris. At first Marie was reluctant to leave Poland because she had a fiancé, Kazimierz Zorawski, but after their break up, she was able to go to Paris in October 1891.

Marie Curie (née Marie Sklodowska).

At the age of 24 she commenced her studies in mathematics and physics. Marie passed her degree in physics in 1893 and her degree in mathematics in 1894 - about one year prior to Röntgen's discovery of x-rays. Marie and the scientific community in Paris were aware and excited by this new type of invisible electro-magnetic radiation

In 1895 in Germany, Wilhelm Conrad Röntgen was able to use electricity to produce the so-called Röntgenstrahlung (Röntgen Rays or X-rays). Compared with light, this part of the electromagnetic spectrum was capable of penetrating human flesh to display the shadow of the bone structure.

Wilhelm Conrad Röntgen.

A year after this, in Paris in early 1896, Henri Becquerel discovered similar penetrating X-ray-like electromagnetic radiation. This time, however, it came from a stone and did not require electricity as in the Röntgen experiments.

Antoine-Henri Becquerel.

Other scientific work that impacted on Marie Sklodowska was that done earlier by Rutherford. The New Zealander, Ernest Rutherford, won a scholarship to study in Cambridge, England under J J Thomson (who, among many other things, proposed the concept of the electron). He managed to detect radio waves at distances of more than 500 metres. His early work on electromagnetic radiation was, however, somewhat eclipsed by that of Marconi who later succeeded in transmitting a message over an incredibly longer distance. Rutherford's studies moved from the radio end of the electromagnetic spectrum to the shorter wave lengths associated with the nature of matter and its radioactive decay.

Ernest Rutherford.

Amid this era of scientific excitement, Pierre Curie appeared on the scene. Compared with Marie, Pierre had a relatively easy and well supported academic life in Paris. Although he was interested in research he had "never got around" to finishing his PhD. With Marie's encouragement, however, he completed his PhD thesis in 1895. They were married in July 1895. Their daughter Irène was born in September 1897.

Pierre Curie.

Marie was intrigued by the work of both Röntgen and Becquerel and decided to study the invisible 'uranium rays'. Eventually there was joint work by both Marie and Pierre on radium salts. A lecture given by Nanny Fröman in Stockholm in 1996 discussed the early days of experimentation and discovery of radium. In this lecture, Fröman illustrated how early experimenters (such as the Curies) received substantial radiation doses. The main thrust of this aspect of the lecture is summarised as follows:

"Pierre Curie demonstrated the properties of radium to the Royal Institute in London. As well as showing how radium salts extracted from pitchblende (radium ore) could produce light, he also investigated some deterministic health effects. He described the medical tests he had carried out on himself whereby he wrapped a sample of radium salts in a thin rubber covering and strapped it to his arm for a period of some 10 hours. The resulting wound day by day resembled a burn, until after 52 days a permanent scar remained."

Despite both Marie and Pierre Curie having scarred fingers and both of them suffering constantly from fatigue (they did, after all, also work long hours), they had no idea that radiation from radium had serious detrimental effects on health. One can only speculate as to whether they would have continued such research if they were fully aware of the likely health effects. For demonstration purposes, Pierre often carried a radium sample in his pocket, while Marie liked to keep a small radium salt sample by her bed because it glowed in the dark.

By today's standards the contamination of their laboratory and their notebooks would be considered unacceptable. Some of their notebooks still survive and are kept in the *Bibliothèque Nationale* in France.

Pierre and Marie Curie must also have been exposed to a significant dose of radiation from breathing in radon, a gaseous decay product of radium.

Their laboratory was an old shed and when they were not able to conduct experiments outside, they relied on natural ventilation through open windows to disperse any noxious gas such as radon.

As with the Curies (and later the Joliet-Curies), the 'father of nuclear physics' Ernest Rutherford was also equally unaware of the hazards of radiation. He and his colleagues also experimented with radium and Rutherford expressed delight when one of his colleagues was able to discharge an electroscope by breathing on it. To Rutherford, this confirmed the existence of airborne radioactive gas.

Although everything appeared to be going well for Pierre and Marie, in 1906 tragedy struck. Pierre Curie died unexpectedly when he was run over by a horse-drawn wagon in Paris. This left Marie a widow with two daughters, Irène aged nine and Ève aged two.

As if this wasn't tragedy enough, in 1911 she was accused by a French newspaper of having an affair and breaking up the marriage of her colleague Paul Langevin.

The newspaper attack and slander escalated and was devastating to Marie (and Langevin). By today's standards, such a friendship some six years after the death of her husband would be barely newsworthy. It should be remembered that the late 1890s in Paris was the time of the Moulin Rouge, the Can-Can, Henri de Toulouse-Lautrec and generally the pleasures of seedier parts of Pigalle.

It seems somewhat hypocritical for the newspapers of the time to take such a puritanical stance. There was also more that a hint of racism in these attacks: "an alien, a Polish woman, a researcher supported by our French scientists, had come and stolen an honest French woman's husband" and "Go home to Poland".

It is no wonder that Marie became depressed and took a long time to recover. Then came World War I.

During this time, with her daughter Irène, Marie Curie ran mobile X-ray machines which travelled from camp to camp diagnosing soldiers' wounds.

After WWI, in Europe and the world generally, there was a period of time of free exchange of scientific ideas, particularly on the nature of matter and the concept of an atom. In Germany, Paris, the UK and many other countries, scientists met on both a formal and informal basis to discuss their latest findings. It was a time of the inception of the awarding of the prestigious Nobel Prize as recognition of scientific excellence.

When Marie Curie died on 6th July 1934, she was first buried with her in-laws and Pierre in Sceaux (Paris). Some 60 years later all seemed forgiven by the French authorities and she and Pierre were re-interred in France's national mausoleum, the Panthéon, in Paris.

Irène and Frédéric Joliot-Curie

Despite witnessing the obvious stress of her mother in earlier times, Irène successfully studied physics in collaboration with husband Frédéric. The now combined Joliot-Curie name became famous for their combined research into atomic nuclei.

Irène Joliot-Curie.

Irène Joliot-Curie and husband Frédéric followed the Curie line of research in France. At the age of 18 (during WWI) Irène assisted her mother by running mobile field hospitals which incorporated X-ray machines. She later worked at the Institute of Radium of the University of Paris, which her parents had started. When she married in 1926 she and her husband focused on research into artificial radioactivity. At the time they did a lot of groundwork towards the later discovery of the neutron by Sir James Chadwick, who was born in Cheshire (Chadwick was working with Hans Geiger in Berlin at the outbreak of WWI - he was able to continue some of his work while interned in Germany).

It was a time when there was recognition of important scientific work by the awarding of the prestigious Nobel Prize. There was keen competition. In 1933 the Joliot-Curies made the important discovery that radioactive elements can be artificially prepared from stable elements. In their experiments they bombarded boron with alpha particles (a positively charged subatomic particle, composed of two protons and two neutrons, identical with the nucleus of the helium isotope He-4), producing a radioactive form of nitrogen.

The Joliot-Curies also had some sympathy for communism at a time when such sympathies were not popular. At a later time, communist leanings (or even

Frédéric Joliot-Curie.

having friends who might be considered as having communist leanings) were considered to be treason, as Oppenheimer found out after WWII in the USA.

While the Joliot-Curies carried out research in France, similar work was being carried out in Austria and Germany.

Lise Meitner

Lise Meitner was born in 1878, in Vienna, Austria, the third of eight children of a Jewish family. She studied physics under Ludwig Boltzmann and later went to Berlin to study with Max Planck and the chemist Otto Hahn. As is said nowadays, "there was intellectual chemistry between Hahn and Meitner" and not always without humour.

Lise Meitner often jokingly referred to her colleague as "my little rooster" (Hahn means rooster in German). The partnership with Hahn lasted for some 30 years, with Hahn being the chemist and Meitner being the physicist in their joint study of radioactivity.

Like Irène Joliot-Curie (but on the opposite side of the war), from 1914 to 1916, Meitner volunteered as an X-ray nurse-technician in Austria. She and Hahn still found time to do research and in 1918 Meitner and Hahn discovered the element protactinium.

It appears that there was some animosity between Lise Meitner and Irène Joliot-Curie. Meitner felt that Joliot-Curie was cashing in on the reputation of her famous mother. The Meitner Joliot-Curie animosity seems to have come to a head in 1933 at a Brussels conference. The Joliot-Curies presented their finding of their experimentation where they bombarded aluminium with neutrons. It was almost unbelievable to many scientists and particularly to Lise Meitner that a "large ping-pong ball" of a particle such as a neutron could

Lise Meitner.

penetrate a nucleus. Lise Meitner claimed that she had conducted similar experiments but had not obtained the same results. As far as Meitner was concerned, the Joliot-Curie result was "unreliable". An attempt was made by Bohr and later Rutherford to smooth the troubled waters, but with little effect.

The crux of the disagreement and animosity seems to be that Joliot-Curies claimed that thorium gave out alpha particles when bombarded. Meitner disagreed with this and requested that her pupil, von Droste, repeat the experiment. He did indeed repeat the experiment with both thorium and uranium and found no alpha particles. Naturally, Meitner felt that she was correct. Had von Droste not used a filter (particularly with the uranium bombardment) to exclude particles with a range under 3 cms (such as alpha particles) he would have confirmed Joliot-Curies experiment and hence confirmed uranium fission (Jungk,1958). It was later said in the Dahlem laboratory (in Berlin, where Hahn and Meitner worked): *"Madame Joliot-Curie is still relying on the chemical knowledge she received from her famous mother and that knowledge is just a bit out of date today".*

It seems that the animosity was not only between Meitner and Joliot-Curie, but also between Hahn and Joliot-Curie. Perhaps symptomatic of an even more "vexatious strain in relations between France and Germany".

Being Jewish, the Anschluss in 1938 made work extremely difficult for Lise Meitner in Vienna and Berlin. This culminated in the necessity for Meitner to secretly escape across the Dutch border and thence to Stockholm. Hahn then had to select a new colleague and it was Fritz Strassman.

The dark secret of nuclear fission

The experimental results published in the 1938 Joliot-Curie and Savich paper convinced Strassman and Hahn (albeit reluctantly) to repeat their experiments, but exactly in the same manner as the Joliot-Curies. This time there was no disagreement with the findings of Joliot-Curie. Hahn and Meitner exchanged letters on a regular basis and eventually Meitner became aware of the concept of fission.

Otto Hahn.

Hahn and Strassmann's famous paper confirming nuclear fission was published on 6th January 1939 in the German scientific journal *Naturwissenschaften*. The theory of nuclear fission was recognised and explained for the first time by Lise Meitner and Otto Robert Frisch in their paper published in the English journal *Nature* on 11th February 1939, after Frisch conducted his "recoil" experiment in which he was able to detect large ionization signals due to the presence of fission fragments.

The injustices - if one might call them that - are in that Joliot-Curies initially had considerable difficulty in having their work believed while Lise Meitner was to a large extent cheated of a Nobel Prize by the politics and racism of the day. It does appear that the eminent women involved in early radiation research have had to endure far more personal hardship than their male counterparts.

Otto Hahn never acknowledged Meitner's contribution to the discovery of nuclear fission. Ruth Sime points out:

"For the rest of his life, Hahn provided a standard explanation: fission was a discovery that relied on chemistry only and took place after Meitner left Berlin; she and physics had nothing to do with it, except to prevent it from happening sooner. Hahn was believed, he was a Nobel laureate, and a very famous man. Strassmann, very much in his shadow, saw it differently. Lise Meitner had been the intellectual leader of their team, he insisted, and she remained one of them, through her correspondence with Hahn, even after she left. Meitner herself said little, other than to point out to the essential interdependence of physics and chemistry throughout the long investigation. Privately, she described Hahn's behaviour as "simply suppressing the past (in Nazi Germany)." And, she added, "I am part of his suppressed past."

The French group also did not receive the recognition for their contribution to the discovery of nuclear fission.

Irène Joliot-Curie died of leukemia in 1956, 10 years after a sealed capsule of polonium-210 was accidentally broken in her laboratory at the Radium Institute in Paris. Lise Meitner gave a moving eulogy in memory of her former colleague. Perhaps the eulogy was in some way an apology for the animosity which had existed between them in the 1930s, when Meitner strongly criticised the Joliot-Curies research and publically doubted their experimental results.

Leó Szilárd fled the Nazis in 1933 and moved to London. He later realised that a chain reaction was possible with all it dreadful implications. This led to the Manhattan Project and the rise of Oppenheimer in the USA. It was given high priority for fear that the Germans might also be working on a similar scheme. Lise Meitner politely declined to work on the Manhattan Project.

Political barriers had now slammed firmly shut around so called 'nuclear' scientists. The end of the years of free scientific discussion had now ended.

References and selected bibliography

- De Laeter, John R (1977). *Radiography education in Australia - Past, Present and Future.* In: A Knights (Ed) *Proceedings of the First National Conference on Radiographic Education, August 1977.* pp 1-14.
- De Laeter, John R (1980). Radiography education at the crossroads. *The Canadian Journal of Radiography, Radiotherapy and Nuclear Medicine.* Mar - Apr 1980. Vol XI No II.
- Fröman, N (1996) *Marie and Pierre Curie and the Discovery of Polonium and Radium.* Originally delivered as a lecture at the Royal Swedish Academy of Sciences in Stockholm, Sweden, on 28th February 1996 (translation from Swedish to English by Nancy Marshall-Lundén).
- Jungk, R (1958). *Brighter than a thousand suns.* Pelican Book Publishing Company
- Sime, Ruth Lewin (1996). *Lise Meitner. A Life in Physics.* University of California Press in 1996.

ar

The mechanical filter

Clive Wallis VK6CSW
RAOTC member No 1289

A filter is a device designed to separate a wanted product from whatever else that product is contained within. Essentially, a radio receiver is a filter which extracts only the wanted signal from all other signals within the electromagnetic spectrum impinging on its antenna, whereas a radio transmitter needs a well filtered signal to avoid radiating spurious energy. The better the filter, the cleaner the wanted signal will be.

Until the advent of Software Defined Radios (SDR) where digital electronics technology is now used to achieve many processes previously only theoretically possible, filters had to be made from some type of hardware, typically a coil-capacitance combination, quartz crystal, ceramic material or mechanical discs. The Q or 'quality factor' of the resonant circuit defines its sharpness or selectivity; the higher the Q the narrower the bandwidth[1].

In general terms the L-C combination rarely has a Q of more than a few hundred, quartz filters up to about 10,000, while mechanical filters can attain a Q of 25,000. Mechanical filters are also extremely temperature stable, far more so than coil-capacitor circuits and rather better than crystal or ceramic filters. Although the mechanical filter can be made to give the best performance in terms of selectivity, shape factor, flat pass-band, temperature and long term stability, it requires very precise manufacturing which is reflected in its price.

All of us are familiar with mechanical and acoustical resonance, whether it be an annoying buzz that happens in the car at some particular engine speed, a rattle in that old loud-speaker at some particular frequency, the tuning fork or the well-known trick of a singer breaking a wine glass by singing at the resonant frequency of the glass. All materials, from concrete and steel to the bones and tissue of the human body, have a natural resonant frequency - and sometimes more than one.

At the resonant frequency, small periodic driving forces (vibrations) have the ability to produce large amplitude oscillations due to the storage of vibrational energy, sometimes with catastrophic results such as a bridge or building collapsing or a wine glass shattering. Subject your abdomen to a strong vibration at about 5-7 Hz and the resonance may well result in a hasty retreat to the loo!

In the radio world, it is the phenomenon of resonance that enables us to filter out what we want from the cacophony of the electromagnetic spectrum.

Pre SDR, one of the best filter types was the mechanical one and probably the best known are those made by Collins Radio (now Rockwell-Collins) from about 1950 onwards and used as intermediate frequency (IF) pass-band filters. Various bandwidths, from a few hundred hertz for narrow band modes such as CW or RTTY to several kilohertz for speech modes, were available. The filter elements required costly precision manufacture hence they usually only appeared in more expensive, high grade communications equipment.

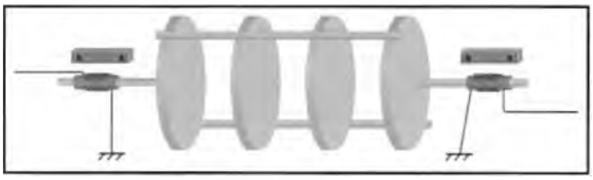


Fig 1. Filter with disc flexural resonators and magnetostrictive transducers.

Although a detailed analysis of the workings of a mechanical filter is well beyond the scope of this article, Fig 1, a mechanical filter with disk flexural resonators, gives us the general idea. While this shows flexural resonance, there are several other resonance modes which may be used such as torsional, longitudinal, radial and drumhead (see Fig 2), but here we are concerned only with the principle of operation.

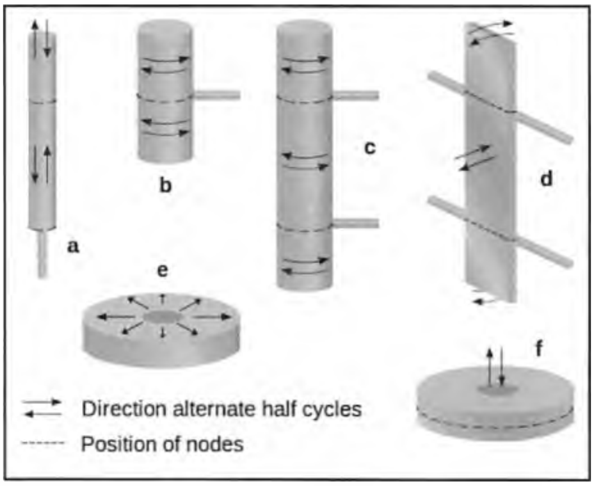


Fig 2. Resonator modes. (a) longitudinal; (b) & (c) torsional; (d) flexural; (e) radial; and (f) drumhead.

Because radio deals with electrical signals and the mechanical filter deals with mechanical vibrations, the first requirement is a transducer to convert electrical energy to mechanical energy. In Fig 1 this is done electromechanically through magnetostriction.

Magnetostriction is a property of ferromagnetic materials that causes them to change their shape or dimensions during the process of magnetisation. Typical materials are ferrite or compressed powdered iron.

In reverse, when these materials are distorted mechanically they produce a magnetic field. Thus the electrical energy in the tuned input coupling coil causes the magnetic core to vibrate, the vibrations then passing mechanically to the first resonant disc. The increased energy of vibration at the resonant frequency is coupled mechanically by tuned rods to subsequent discs with the last disc coupled to a ferromagnetic rod which, via electromagnetic transduction, creates the electrical output signal ready for further electronic amplification and processing. Each disc has a narrow resonant frequency band, electrically equivalent to a very high-Q element, thus only the desired range of frequencies (passband) will be accepted through the filter, all others being rejected.

Early mechanical filters often used steel as the resonant element but the more modern preference is for various nickel-iron alloys. The resonators in filters made of these materials have to be machined precisely to the desired resonant frequency prior to final assembly. Fig 3 shows that by careful design and precision manufacturing a filter of the desired band-pass width with very steep cut-off can be achieved, far better than can be achieved with IF coils and somewhat better than a quartz crystal filter.

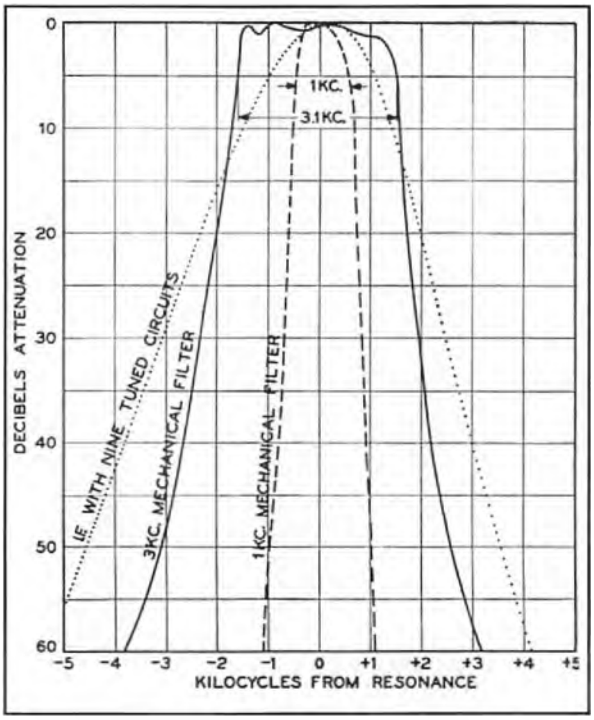


Fig 3. Comparison of passbands (*QST*, February 1953).

Although the example in Fig 1 shows magneto-striction, another common coupling method between electrical signals and mechanical movement is by the piezoelectric effect. Here a quartz crystal element is placed in close contact with the mechanical element, the piezoelectric effect vibrating the crystal which, in turn, excites the mechanical element at its resonant frequency. Fig 4 shows the internal construction of a mechanical filter using torsional (twisting) mode resonators with piezoelectric input and output transducers, while Fig 4a illustrates the longitudinal mode.

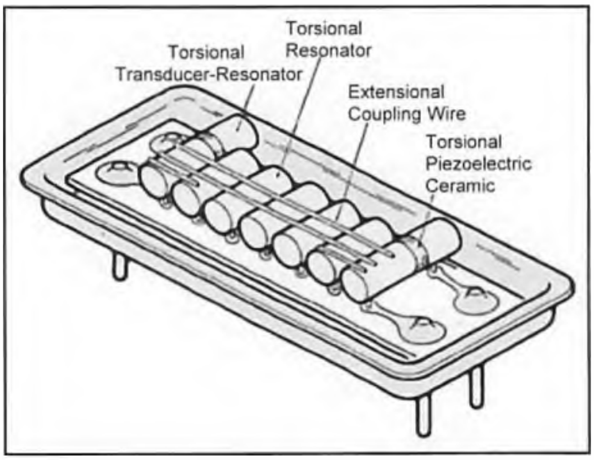


Fig 4. Mechanical filter using torsional vibration mode, with piezoelectric input and output coupling.

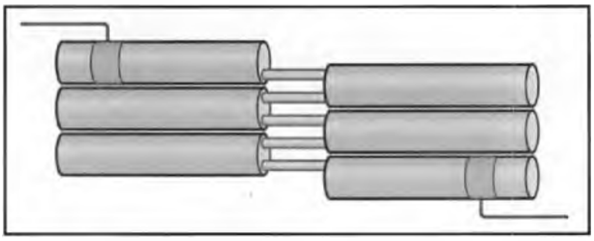


Fig 4a. Longitudinal mode resonators and piezo transducers.

It may come as a surprise that the idea of mechanical filters in electric circuits predates the invention of the telephone by several years. By the mid-1800s the electric telegraph was in widespread use but, until the invention of the 'harmonic telegraph' in 1870, only one message at a time could be sent over one line. Although electrical resonance was known at this time it was poorly understood, however engineers had a good grasp of mechanical and acoustic resonance. The idea behind the 'harmonic telegraph' was to send several telegraph signals over a single line, using different tones.

Each operator's key activated a vibrating electromechanical reed which converted the direct current into a precise electrical tone. At the receiving end filtering was achieved by a similar reed tuned exactly to the transmitted tone, thus it vibrated only to that tone. By this means several operators could use the one line simultaneously, conferring significant commercial and financial advantage to the telegraph company. Today we would call this frequency-division multiplexing.

Much later, similar vibrating tuned reed technology, that is mechanical filtering, was used in early Selcal (selective calling) systems prior to the introduction of electronic tone decoding, and also for the radio control of model aircraft between about 1950 and 1970.

Another early example of mechanical filtering was the Harrison gramophone horn of the 1920s. A major problem with early gramophones or phonographs was poor sound quality caused by mechanical resonances in the pick-up and amplifying horn, creating peaks and troughs in the reproduced sound.

Mathematically, mechanical and electrical filter design is interchangeable; a mechanical design can be represented by an electrical circuit. In 1923, Harrison, then employed by the Western Electric Company, filed a patent for a mechanical phonograph where each component from pick-up needle to horn was represented as an electrical circuit, as shown in Fig 5 on the next page.

The horn of the phonograph is represented as a transmission line, and is a resistive load for the rest of the circuit, while all the mechanical and acoustic parts - from the pickup needle through to the horn - are translated into lumped components according to the impedance analogy[2]. Essentially, this was a mechanical bandpass filter with a substantially flat response from 100 Hz to 6 kHz.

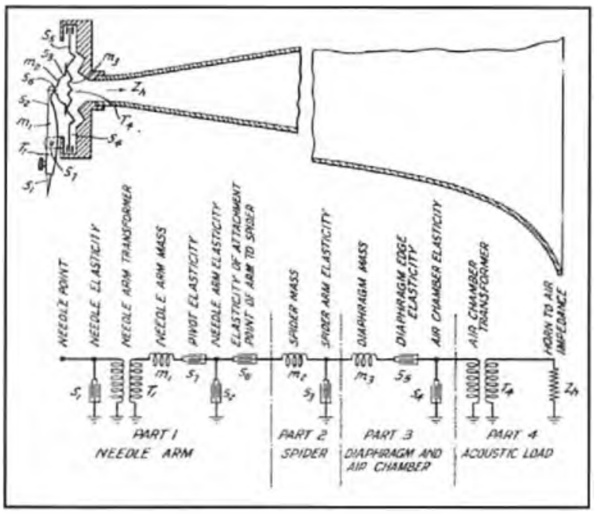


Fig 5. Harrison's phonograph mechanism and its electrical equivalent circuit.

The design was further improved by Norton of Bell Laboratories in 1929 with his 'maximally flat' mechanical reproducer. Norton's mechanical design predates by a year the paper entitled *On the Theory of Filter Amplifiers* published by the British engineer and physicist Stephen Butterworth in 1930. Butterworth is usually credited as the first to describe the electronic maximally flat filter (the Butterworth filter is characterised by minimum ripple in the passband).

The definitive description of the subject from this period is the 1926 paper by Maxfield and Harrison where they describe not only how mechanical bandpass filters can be applied to sound reproduction systems, but also apply the same principles to recording systems and describe a much improved disc cutting machine.

However, by the 1930s electrical recording and reproduction was making rapid strides and soon eclipsed the old mechanical methods. But, as many readers will recall, mechanical gramophones were still in widespread use in the early 1940s though the recordings played would almost certainly have been made electrically.

Today, loudspeaker systems utilise both mechanical and acoustical filter design, enabling remarkable performance to be obtained from physically small systems.

Although acoustic mechanical filters were used to a limited extent in some types of WWII sonar systems, large scale production of acoustic frequency mechanical filters was first undertaken in the 1950s by the Collins Radio Company, Cedar Rapids, Iowa. These were used in telephone frequency-division multiplex systems where, not unlike the idea first mooted in the old 'harmonic telegraph' system, many conversations could be carried simultaneously on a single line, be it open wire or, later, coaxial cable.

The exceptional temperature stability, flat pass-band and steep cut-off characteristics of these mechanical filters, see Fig 6, led to a reduction in the required guard band between channels and hence increased the number of channels carried per cable. Although costly, these filters conferred a worthwhile commercial advantage[3].

High-Q mechanical filters designed for the higher radio frequencies soon found their way into the IF stages of more expensive commercial and amateur radio

Fig 6. Mechanical filter from a telephone carrier system using torsional resonator elements.

equipment manufactured by Collins. Like their telephone counterparts, these mechanical filters achieved much higher Q-factors than were possible with conventional coil IF transformers or even quartz crystal filters and soon became popular in the more expensive types of radio communications equipment.

The nature of conventional mechanical filters limits their upper frequency to about 1 MHz; most are made to operate at about 455 kHz, whereas quartz crystal filters can operate up to around 100 MHz. Double or triple conversion receivers, which used up-conversion with a first IF of around 40-70 MHz or higher, invariably employed a crystal filter at this point with perhaps a mechanical filter for the second IF of around 455 kHz. However, the more recent development of micro-electromechanical systems (MEMS) has the potential to change that.

MEMS are micro-machines with component sizes measured in millionths of a metre and may be considered as corresponding to the mechanical world as integrated circuits correspond to the electronic world. Like ICs, MEMS devices pack a lot of technology into a very small space. These devices are now becoming widespread.

Some common commercial applications of MEMS include tiny accelerometers found in car airbags; MEMS gyroscopes are used in drones for stabilising flight; in road vehicles for electronic stability control; and in cell phones to rotate pictures and script, etc. They are also being employed as mechanical filters for RF.

One type of MEMS RF filter uses a cantilever resonator, somewhat like the vibrating reed of yesteryear, but made of silicon based components and manufactured by methods similar to those used in the semiconductor industry. Fig 7 shows one of these incredibly tiny devices in operation. Such filters can operate at very much higher frequencies than the traditional mechanical filter, typically up to 200 MHz.

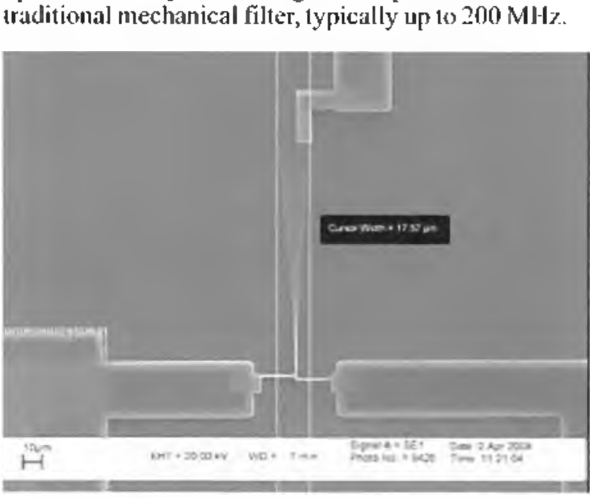


Fig 7. MEMS cantilever resonator at resonance.

Other structures, such as micro-machined cavities, can be used at microwave frequencies. MEMS technology can produce extremely high Q resonators; flexural mode resonators with a Q in excess of 80,000 at 8 MHz are reported. Perhaps these will be the mechanical filters of the future.

What started out around 150 years ago as an idea for multiplexing Morse code telegraph messages has come a long, long way!

Notes

1. The concept of Q originated around 1914 with K S Johnson of Western Electric Company's Engineering Department while evaluating the quality of coils (inductors). His choice of the symbol Q was only because, at the time, all other letters of the alphabet were taken. The term was not intended as an abbreviation for 'quality' or 'quality factor', although these terms have grown to be associated with it. By 1924 Q was firmly established in the electronics industry.

2. Some readers may query the reason for the electrical circuit shown below the horn in Fig 5. Mathematically, electrical, mechanical and acoustic resonance have much in common. The mathematical analysis of mechanical filters is analogous to that of electrical filters. A passive linear electrical network is made up of inductors, capacitors and resistors; respectively these have the properties of inductance, elastance (inverse capacitance) and resistance. Their mechanical counterparts are, respectively, mass, stiffness and damping. Similarly, the mechanical counterpart of voltage is force, while current equates to velocity, and these represent the signal waveforms.

Most electronic filter designs use only inductors and capacitors, though resistors may be used at the input and output terminals. Resistances are absent in a theoretical design using ideal components, but are unavoidable in a practical design and appear as parasitic elements. Likewise, an ideal mechanical filter would have properties of mass and stiffness only, but in reality some damping is also present. In this type of analysis a mechanical impedance can be defined, analogous to the electrical filter.

3. As far as I can ascertain, these were audio frequency filters to tightly contain the Bell Telephone's speech audio spectrum of 200-3500 Hz, which was then used to modulate individual single sideband RF carriers. Because each carrier now had a closely defined bandwidth of 3300 Hz, a number of channels could be combined within a single coax cable with only a small guard band needed to prevent mutual interference between channels.

One example is the use of a single coax to carry 12 channels, each 4 kHz wide including guard band, with carriers from 60 to 108 kHz. Such multi-carrier two-way systems are complex and require many other filters as well. No doubt Collins would have supplied these too. Frequency-division multiplexed telephone systems are now largely replaced by time-division multiplexing techniques or digital systems.

References

This article is a digest of information mostly from Wikipedia and Wikiwand with additional material from the *ARRL Handbook*; *QST*, February 1953; plus 'hands on' information from Chris VK6JI, Richard VK6BMW and Phil VK6SO.

ar

Melbourne March 2018 luncheon

Bill Roper VK3BR
RAOTC member No 978

The Melbourne RAOTC March 2018 luncheon was held on Thursday, 22nd March at the usual venue, the Bentleigh Club in Bentleigh. 40 members were present to enjoy the excellent three course meal and white table service. Apologies were received from two members who were unable to attend at the last moment.

After we had all dined well, we then listened to a most interesting PowerPoint supported talk from the guest speaker, Inspector Peter Ferguson from Victoria Police. Peter has been working at VicPol radio communications, or D24 as it is famously known, for almost 20 years and as the officer-in-charge for much of that time.

Peter had originally been booked to speak at our last luncheon but unfortunately was struck down with the 'flu at the last minute. However, his talk was well worth waiting for.

He covered a little of the earlier history of D24 but mainly spoke about police communications over the past two decades, the changes in equipment both in vehicles and personal radios used by individuals, and the new, very fast computers now in all patrol vehicles.

More than a few listeners were envious when Peter described the current police mobile command centres communications vehicles used in emergency situations.

Inspector Peter Ferguson listening attentively to a question from the audience.

It was also very interesting to learn of the criteria used when asking for tenders to supply new police personal radios and to learn that, as previously, Motorola came out tops.

After answering many questions, Peter was then presented with an RAOTC engraved crystal wine glass as a memento of the occasion.

ar

The Jefferson disc

John Sutcliffe VK3TCT
RAOTC member No 1589

Over the centuries hiding the meaning of messages was necessary to stop the opposition knowing what your next moves were. Messages were hidden in the commercial world, by Government and by the military. While the latter is obvious, commercial firms used encryption to hide from prying eyes, for example, the prices paid on the free market for different commodities . Remember when firms used a simple code to show the buying price for a product on the item label so that the salesman knew how far to discount a product?

The Romans used a simple system for communication with their generals by substituting the letters using an offset of the alphabet. For example, if the alphabet is written down (26 characters) then another alphabet is written below offset by, say, three characters it would look like this:
abcdefghijklmnopqrstuvwxyz, then offset below;
defghijklmnopqrstuvwxyzabc, then substituting from top to bottom say 'DOG' , the result would be 'GRJ', the true meaning has been hidden. This system is simple and would be quickly decoded by a decrypting specialist. This form of encryption is called mono-alphabetic substitution.

In 1553 poly-alphabetic substitution was invented, and then re-invented in the 19th century by Blaise de Vigenère. Most of the modern cyphers originated from these ideas and at one time were considered un-crackable.

The German Enigma machine is based on this system and Alan Turing pulled that apart during WWII. Today modern digital computers would make this system indefensible.

Describing this system is beyond the scope of this article and if one is interested then one should research this on the internet. Wikipedia has good articles on these systems.

Thomas Jefferson invented a poly-alphabetic encoding/decoding disc (cylinder) in 1795 just 15 years after Captain Cook discovered Australia. The disc was remarkable and was used for almost 150 years handling secure messages for military and Government.

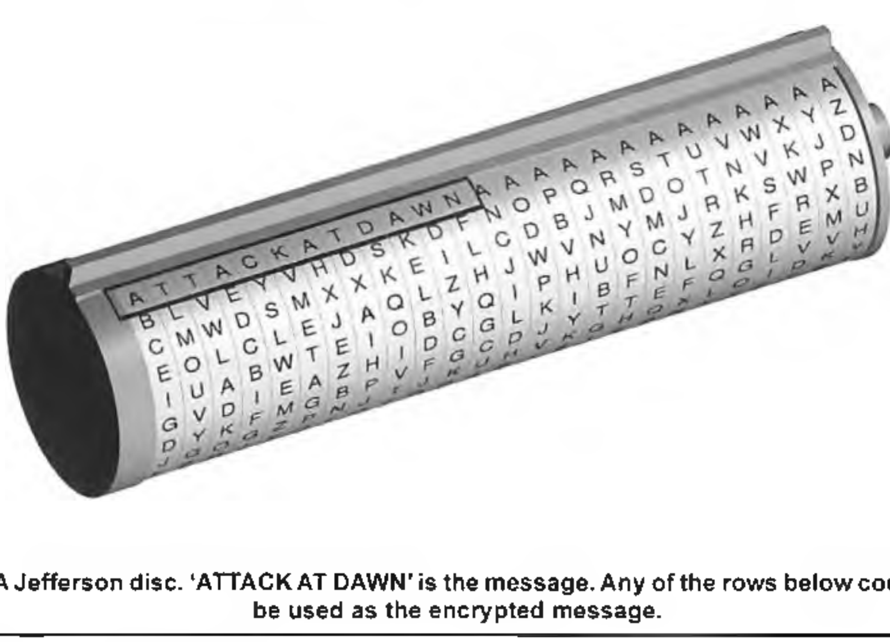
Thomas Jefferson, 1743 - 1826. Third President of the United States of America.

Data encryption became most necessary with the advent of radio communications.

During WWI the Russian army learnt the hard way that communications must be secure. Russian war production and distribution were poor. Through the lack of telephone cable and non-distribution of cipher keys, the Russians sent radio messages on military arrangements in-the-clear (unencrypted).

The battle of Tannenberg, fought from 26th-30th August 1914, claimed the almost complete destruction of the Russian second army and, after a series of follow up battles, most of the first army was destroyed as well.

Sending messages in-the-clear was a gift to the listening Germans and brought prestige to the German Commanders Field Marshal Paul Von Hindenburg and his staff officer Erich Ludendorff. If only the Russians had had the Thomas Jefferson disc



A Jefferson disc. 'ATTACK AT DAWN' is the message. Any of the rows below could be used as the encrypted message.

to encode and decode their messages the results may have been very different.

Jefferson was the third president of the United States and ranked as one of the greatest. Jefferson had a long list of achievements including the writing of the 'Declaration of Independence'.

Jefferson was well educated in the traditional disciplines and was multilingual; he also mastered disciplines from surveying and mathematics to farming and mechanics; Jefferson also practiced as a lawyer, at times representing Negroes seeking their freedom even though he was an active farmer with hundreds of slaves on his own properties.

The Jefferson disc was also known by other names such as the 'Jefferson cylinder' or later as the 'Bazeries Cylinder'. Although originally invented much earlier by Jefferson, this type of cipher machine became generally known after its later re-invention by Commandant Etienne Bazeries as the 'Bazeries Cylinder'.

The Jefferson disc was a device for encrypting alphabetical data to hide the real meaning or purpose from other people and, as such, was used by American commanders through the 19th and 20th centuries including World War II .

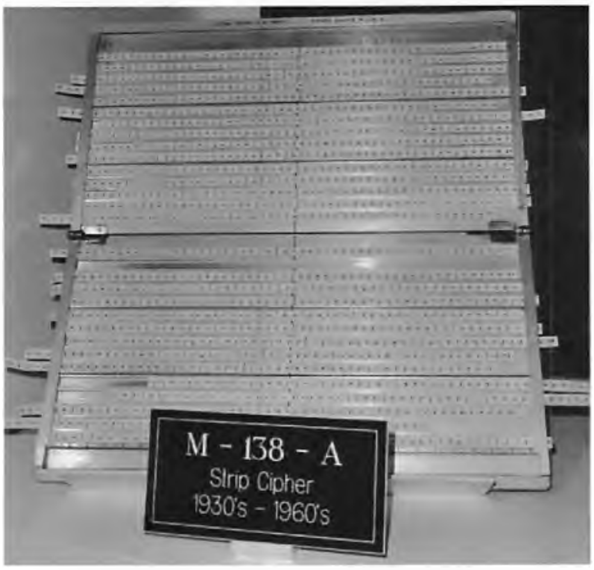
US Army encryption disc M-94.

From 1923 until 1942 it was known as the M94; however, the cipher was then again modified as the M-138-A to improve its security. The disc was a relatively strong system at the time (compared to many other systems in use), and Etienne Bazeries, a very outspoken man, is said to have regarded it as indecipherable. In fact, if used as a one-time pad[1] it is almost impregnable.

Manually testing of the cipher on the disc by hand was impractical. Digital computers would make such a break near trivial for a 10 disc cylinder, but not for the 36 cylinders that Jefferson used.

The code-breaking group of the German Foreign Office cracked the M-138-A in 1944. However, by that time the information was of little use as most of the information deciphered was bad news for the Germans and the Americans had switched to much more sophisticated cipher systems.

The Jefferson disc was constructed as a series of thirty six wooden discs, each disc having the complete alphabet of twenty six characters inscribed around the rim in random order. Imagine a penny with the alphabet inscribed around the edge with a hole in the middle. The discs were assembled on a shaft and looked like a cylinder when assembled. As each assembly needed to be identical, all individual discs were numbered with each disc of the same number having the same letters around the edge in the same order.



The M-138-A strip cipher machine used by the US Navy and US State Department through WWII featured 100 flat strips. Each strip had a scrambled alphabet, repeated twice, printed on a metal strip that could be slid back and forth in a frame, with 30 being selected for each cipher session.

The cipher cylinder had a screw nut on one end so the discs could be locked in one place. The operation to encode a message was quite simple. All one had to do was turn each separate disc from left to right to make up the word required from the characters on the edge of the discs. When satisfied with the spelling, etc the operator then turned the cylinder around a row or more and wrote down the characters from left to right from one row.

The characters written down were then radioed or telegraphed to the other station which, on reception, arranged the received characters to any row on its own cylinder. Now, assuming both discs were identical, once the receiving station arranged the received characters on a row, the entire cylinder or disc was then rotated until a row was found that was not gobbledy gook and, hey presto, there was the correct word or message!

Jefferson had served his country well as a lawyer, statesman, president, inventor and served in several overseas posts on behalf of the American government. Towards the end of his life he was deeply concerned that he would be leaving little to his heirs due to the level of his debts which were in excess of one hundred thousand dollars.

His debt was not totally of his own making although he enjoyed the good life including fine French foods. The end came on 4th July 1826.

Jefferson died within five hours of his revolutionary mate, then adversary, John Adams, who was the second president of the United States.

Note

1. In cryptography, a one-time pad is a system in which a private key generated randomly is used only once to encrypt a message that is then decrypted by the receiver using a matching one-time pad and key. When applied correctly, the one-time pad provides a truly unbreakable cipher. It is named after the sheets of paper (pads) on which the key stream was usually printed.

Reference

https://wikipedia.org/wiki/Polyalphabetic_cipher

ar

A bad case of ignition noise - the Pye FM-734 story

Cal Lee VK3ZPK
RAOTC member No 1510

Sometimes it takes an event of tumultuous nature to enlighten one, a bolt out of the blue so to speak, when all is revealed.

The Pye FM-734 was, as far as I know, the very first small two-way radio to be produced in Australia. Designed and built in the Pye Pty Ltd, Clayton (Victoria) factory in 1967/8, it was a real eye opener. About 220 mm x 220 mm x 50 mm it was about the same size as a car radio broadcast receiver of the time, yet this smallish case contained a 25 watt transceiver covering 68-88 MHz initially, and was also released for 148-172 MHz a few months later.

Maybe it was because it was the first of these small size transceivers, that most in the trade were inclined to excuse the 734, as it became known, a few shortcomings. Whilst the 10 watt model could make about 10 watts of RF power, the 25 watt version struggled to do so in a stable fashion, but could produce about 18 watts. The receiver, although sensitive enough and dual conversion with a 29.8 MHz first IF, was prone to ignition interference.

This was a real and sometimes unacceptable problem with some customers.

Many FM-734 Radios were returned to Pye because of this. Pye, to their credit, investigated all of these cases, but no complete cure was ever found.

Eventually, though, the 734 was superseded by the FM-806 model and the problems were very much reduced if not eliminated. Naturally, lots of 734s remained in use in the field, largely because installers had gone to great lengths to suppress the vehicles in which they were installed.

I must say that during this time I often underwent the experience of stopping at a red traffic signal with silence from my 734 (my car ignition was fully worked over) when another vehicle would pull up beside me and produce a rat-a-tat-tat in my radio.

How do you fully suppress all vehicles on the road? Motor cycles were by far the worst.

Are you ready for the eureka moment?

Well, long after all the years of angst of the 734 ignition noise problems, something of a eureka moment occurred!

This is what happened.

Some time during 1970 or 1971 at our two-way Radio Workshop at Geelong we were presented with a 734 that, in technician terminology, was deaf - the receiver had lost sensitivity.

The technician on bench No 3 in our workshop fed many millivolts of signal into the 734 receiver in an attempt to find out where the problem was. Much to the surprise of the technician at bench No 1, he could hear the signal in a 734 on his bench. This was it! The first IF of 29.8 MHz was radiating from the 734 on bench No 3 to the 734 on bench No 1. It was IF breakthrough!

IF breakthrough

Why? Well, usually when a radio is designed, one of the considerations is that the wiring, etc in the IF section is all kept short and/or shielded so that it doesn't become an antenna. And, indeed, when you

The wiring to the second mixer of the radio with the 29.80 MHz crystal filter at the far right.

look at the first few FM-734 radios released you can see that the 29.8 MHz crystal filter is mounted flat on an aluminium plate with short leads to the input and output transformers. Later on, someone evidently considered that raw aluminium looked poor and the plate was anodised black.

There was the problem! The anodising insulated the filter case and in doing so created two problems.

Firstly, the filter became less effective, having poor shielding between input and output and, secondly, the input to the first IF amplifier became 'aerialised' through the much longer path to earth.

But what does this all mean?

The fact is that the 734 was two receivers in one, the first listening on the channel frequency, say 81.18 MHz, and the other receiving on 29.80 MHz, the first IF frequency. This explained why and how the ignition interference was getting into the radio.

Perhaps now, in retrospect, the following observations are interesting to contemplate:

1. The 734 ignition noise problem crept up on the users. The first radios built seemed to be OK.
2. Not all radios were bad.
3. Not all cars were bad.
4. Sometimes no amount of suppression on a vehicle would eliminate the noise, and sometimes no matter how strong the signal, the ignition impulse noise persisted. But then a different brand or model of radio in the same car was OK.

Final Comment

If you were going to build a traditional noise blanker using a separate noise receiver, what part of the spectrum would you listen to with that separate noise receiver? Well, somewhere where you expect the noise to be prevalent. Say, 40 MHz, 33 MHz, or 30 MHz - that's where the most common commercial units are.

How about 29.8 MHz for a choice?

Sometimes it takes a bolt from the blue! ar

RAOTC members list

as at 31st July 2018.

Legend: L = Life Member A = Associate Member B = Associate Life Member
* = Licensed 50 years or more + = Aged 90 years or more

	Name	Call	No
	ACT		
L	Ted Peppercorn	VK1AEP	1314*
A	Chris Thompson	VK1CT	1717
L	Ernie Hocking	VK1LK	1260
B	Andrew Robertson	VK1NRO	1611
	NSW		
	Don Hunt	VK2ADY	1141
L	George Paterson	VK2AHJ	1333+
L	Ben Mills	VK2AJE	832+
L	Jim Patrick	VK2AKJ	1003
	Alan Whitmore	VK2ALA	1381
L	Max Mondolo	VK2AML	1227
	Max Riley	VK2ARZ	1518*
L	Tony Mullen	VK2BAM	882*
L	John Trenning	VK2BAR	1226*
	Steve Leatheam	VK2BGL	1498*
	George Archibald	VK2BGU	1360
L	Brendan Connolly	VK2BJC	1213
	John Marland	VK2BJU	1399*
	Peter Bass	VK2BPB	1726
L	Ray Gill	VK2BRF	1592
	Lex Brodie	VK2BYA	1638
	Dave Rothwell	VK2BZR	1414
	Ken McCracken	VK2CAX	1730*
	John Clark	VK2CF	903*
	Peter Presutti	VK2CIM	1705
	Neale Imrie	VK2CNI	1480
L	Ray Turner	VK2COX	1348*
	Dot Bishop	VK2DB	1403
	Dean Davidson	VK2DJD	1423
	Brian Kelly	VK2DK	1645
	Al MacAskill	VK2DM	1277*
	Trevor Wilkin	VK2ETW	1570
	John Boyd	VK2EZC	992*
A	Syd Brooksby	VK2FACG	1736
L	Glen Millen	VK2FC	1180
L	Nick Perrott	VK2FS	1327
	Ray Davies	VK2FW	1563*
L	Gary Baxter	VK2GAB	1504
L	Allan Mason	VK2GR	1221
L	Peter Ritchie	VK2HC	1326
	John Rath	VK2HY	1534*
	Ian Jeffrey	VK2IJ	1571
	Ralph Parton	VK2IRP	1301
	Herman Willemsen	VK2IXV-ex	1384
	John Lockwood	VK2JL	1678*
L	Pat Leeper	VK2JPA	1629
	Kevin Parsons	VK2JS	1586
	Graeme Scott	VK2KE	789*
	Greg Hilder	VK2KGH	1375
	Barry Wood	VK2LA	848*
L	Tom Sanders	VK2MY	1393
L	John Gaynor	VK2NCE	1475+
L	William Spedding	VK2NLS	1394
	John Sullivan	VK2OH	1687
L	George Hodgson	VK2OH-ex	544
L	Mike Rautenberg	VK2OT	1335
L	Peter Mair	VK2PF	1318
L	Roger Conway	VK2RO	1255
	Trevor Hoodless	VK2RU	1673*
	Robert Ward	VK2TAX	1625
L	Robert Taylor	VK2TR	1469
A	Reg Hawkins	VK2TRH	1727
	Trevor Thatcher	VK2TT	1080*
	Ray Wells	VK2TV	1076
L	Eric De Weyer	VK2VE	1253
L	Barry Mitchell	VK2WB	1456
L	Keith Sherlock	VK2WQ	1138+
	Brian Rodgers	VK2XFL	1608
	Jack Hodge	VK2XH	1605
L	Richard Cortis	VK2XRC	1474
	Ron Cameron	VK2XXG	1410
	Gary Ryan	VK2ZKT	1267
	John Bishop	VK2ZOI	1404
L	Steve Grimsley	VK2ZP	465+
L	Robert Alford	VK2ZRJ	1444
L	Sam Faber	VK2ZZ	1359
	Victoria		
	Peter Doolan	VK3ACJ	1549
L	Graham Rutter	VK3ACK	1322
L	David Rosenfield	VK3ADM	1622*
L	David Wardlaw	VK3ADW	408*
L	Ron Cook	VK3AFW	824*
L	Bob Duckworth	VK3AIC	1245*
	Dave Parslow	VK3AIF	1552
	Rob McNabb	VK3AIM	829*
L	Ken Young	VK3AKY	1103+
L	Tony Smith	VK3ALS	1521
	David Waring	VK3ANP	1037
L	Bill Babb	VK3AQB	904+
	Roy Badrock	VK3ARY	1211*
L	David Stuart	VK3ASE	1346
	Ivan Brown	VK3ASG	1669*
	Max Carpenter	VK3AUA	1489+
L	Ron Mackie	VK3AVA	1478
	Laurie Middleton	VK3AW	1152
	David Swallow	VK3AWX	1747
L	Rod Green	VK3AYQ	1380
L	Roy Thorpe	VK3BAM	1323
	Carl Dillon	VK3BBW	1618*
	Tim Humphery	VK3BCN	1620
	Neil Muscat	VK3BCU	1695
L	Brian Tideman	VK3BCZ	1184
	Mike Goode	VK3BDL	1610
L	Digger Smith	VK3BFF	1424
	Peter Cossins	VK3BFG	1257
	Ed Roache	VK3BG	1692*
L	Muriel Plowman	VK3BJO	1511
	Noel Jeffery	VK3BMU	1021
L	Alex Edmonds	VK3BQN	1341
L	Albert Hubbard	VK3BQO	1506
L	Bill Roper	VK3BR	978*
L	Stan Roberts	VK3BSR	1272+
	Mark Gillespie	VK3BU	1661
L	Graeme Brown	VK3BXG	1542
L	Andy Walton	VK3CAH	1599
L	John Machin	VK3CCC	1421
	Bob Crowle	VK3CDV	1588
	Ken Morgan	VK3CEK	1457
L	Mick Ampt	VK3CH	1365
L	Vic Punch	VK3CKD	1250
	Kevin Leydon	VK3CKL	1557
L	Dick Webb	VK3CP	972*
	Clint Jeffrey	VK3CSJ	1648
	Don Jackson	VK3DBB	1290
L	Mike Pain	VK3DCP	1204
	Helmut Inhoven	VK3DHI	1742
	Doug Twigg	VK3DIJ	679*
	Jim Goding	VK3DM	1744*
L	Russell Ward	VK3DRW	1376
	Peter Cosway	VK3DU	1447*
	Peter Milne	VK3DV	1546*
	Bill Fanning	VK3DWF	1038*
L	Nigel Holmes	VK3DZ	1435
L	Sarjiet Singh	VK3EAM	1052
L	Dallas James	VK3EB	1238
L	Steve Harding	VK3EGD	1524
L	John Eggington	VK3EGG	1683
L	Mark Harris	VK3EME	1574
	Bob Frencham	VK3EQQ	1684
	Ellis Pottage	VK3FG	1087*
	Dave Bell	VK3FGE	1339*
	Noel Ferguson	VK3FI	1416*
L	Ernie Walls	VK3FM	1401
	Peter Lord	VK3FPL	1590
L	Ray Taylor	VK3FQ	1216
L	John Brown	VK3FR	1407
	Geoff Wilson	VK3GJW	1658*
L	Lee Moyle	VK3GK	1363
	Max Morris	VK3GMM	1265
	Graeme Harris	VK3GN	1630
A	John Piovesan	VK3GU	1235
A	Bruce Stokes	VK3HAV	1613
A	Phil Maskrey	VK3HBR	1387
A	John Kirk	VK3HCT	1427
L	Luke Steele	VK3HJ	1432
L	Steve Bushell	VK3HK	1001
B	Phil Cardamone	VK3HPC	1539
A	Roger Schembri	VK3HRS	1644
L	George Francis	VK3HV	620*
L	Bill Jamieson	VK3HX	1117*
L	Gavin Brain	VK3HY	1304*
	Ian McFarlane	VK3IDM	1332
	Peter Collins	VK3IJ	1686*
L	Tim Hunt	VK3IM	504

	Name	Call	No
L	Ian Palmer	VK3IN	1643
	Lindsay Allen	VK3IQ	1674
L	Barry Gauntlett	VK3JB	267+
	Ray Proudlock	VK3JDS	1585
L	Graeme Mann	VK3JGM	1274
	Ray Lenthall	VK3JH	1663
L	Anthony Rogers	VK3JIA	1287
	Craig Gliddon	VK3JK	1701
	Dave Wilson	VK3JKY	1278
	Fred Storey	VK3JM	1010
	Peter Drury	VK3JN	1567
	Ian Sturman	VK3JNC	1218
	John Walters	VK3JO	1288*
L	Ian McLean	VK3JQ	1215
	Frank Nowlan	VK3JR	1286
L	Ian Godsil	VK3JS	1220
L	Bill Magnusson	VK3JT	1342*
L	Steve Phillips	VK3JY	1266
	Barrie Halliday	VK3KBY	1523
L	Ralph Comley	VK3KDD	1461
L	Jim Baxter	VK3KE	1354
L	Craig Cook	VK3KG	931*
L	Paul Karlstrand	VK3KHZ	1528
L	John Blackman	VK3KJB	1319
L	Jim Hinton	VK3KJH	1366
L	Reg Lloyd	VK3KK	506*
L	Maurie O'Keefe	VK3KO	1336+
	Victor Self	VK3KSF	1254
L	Mike Ide	VK3KTO	1194
	Peter Clark	VK3KU	1573
L	Alan Heath	VK3KZ	1151
L	Jack Williams	VK3LG	565+
	Colin Middleton	VK3LO	1153
	Warren Moulton	VK3LX	976*
	David Davies	VK3MHV	1293
	Wally Maxwell	VK3MJW	1720
L	Rob Whitmore	VK3MQ	1352
	Peter Young	VK3MV	1400
L	Graeme McDiarmid	VK3NE	1485
L	Neville White	VK3NZ	1343
L	Alan Baker	VK3OA	1646
	Bill Miller	VK3OI	1598
	Jock Mackenzie	VK3OQ	1619
L	Peter Freeman	VK3PF	1443
	Mark Stephenson	VK3PI	1632
	Stewart Mair	VK3PR	1641
L	Peter Simons	VK3PX	1408
	John Longayroux	VK3PZ	1553
L	Bruce Plowman	VK3QC	1448+
L	Ian Hocking	VK3QL	1594
	Ray Dean	VK3RD	1577
L	Darrell Edwards	VK3RE	1185
B	Blayne Bayliss	VK3RF	1412
	Ron Sutcliffe	VK3RS	1425
L	Peter Wolfenden	VK3RV	1484*
	Ray Wales	VK3RW	1471
L	Damien Vale	VK3RX	1239
L	Sarah Dowe	VK3SD	1535
	Barry Schrape	VK3SW	1560
L	Barry Abley	VK3SY	1496
	John Sutcliffe	VK3TCT	1589*

	Name	Call	No
	Deane Blackman	VK3TX	1378*
	Colin Durrell	VK3UDC	1244
L	Mike Thorne	VK3UE	1473
	Rodney Champness	VK3UG	1086*
L	Bruce Bathols	VK3UV	1090
	Kev Trevarthen	VK3VC	1115*
L	Trevor Pitman	VK3VG	1246
A	Jeff Silvester	VK3VJS	1582
L	David Harms	VK3VL	1383
L	Greg Williams	VK3VT	1402
	Rick Morris	VK3VXI	1497
L	Peter Dempsey	VK3WD	1544
L	Brian Endersbee	VK3WP	1491*
L	Jenny Wardrop	VK3WQ	1656
	Dennis Sillett	VK3WV	1668*
L	Ian Keenan	VK3XI	1527
	John Cheeseman	VK3XM	1746
	Bob Tait	VK3XP	1689
	Ted Egan	VK3XT	721*
	Drew Diamond	VK3XU	1140
L	Derek McNiel	VK3XY	1370
	Tim Robinson	VK3YBP	1617
L	Brewster Wallace	VK3YBW	1126
L	Eric Day	VK3YHN	1398
L	Terry McIntosh	VK3YJ	1532
	Peter Godfrey	VK3YPG	1685
	David Ditchfield	VK3YSK	1732
	Don Bradbury	VK3YV	1580*
L	John Bennett	VK3ZA	939*
	Alan Hayes	VK3ZAH	1711
L	Bob Neal	VK3ZAN	1030+
	Ken Benson	VK3ZGX	1377
L	John Horan	VK3ZHJ	1541
	Kevin White	VK3ZI	1568
	Ian Baxter	VK3ZIB	1519
	Don Seedsman	VK3ZIE	1068*
L	Jim Gordon	VK3ZKK	1262
	Tony Zuiderwyk	VK3ZMP	1733
	Geoff Angus	VK3ZNA	1482*
	Cal Lee	VK3ZPK	1510
	Eric Gray	VK3ZSB	1451*
	Leigh Tuckerman	VK3ZTU	1468*
	Bill Adams	VK3ZWO	1356+

Queensland

	Name	Call	No
	Terry Stewart	VK4AAT	1739
L	Tom Ivins	VK4ABA	1382*
	Colin Gladstone	VK4ACG	1703
	Ian Saunders	VK4ACU	1390
	Doug Hunter	VK4ADC	1697*
	Geoff Adcock	VK4AG	1718
	Jim Brown-Sarre	VK4AGF	1640*
	George McLucas	VK4AMG	1675*
L	Harold Cislowski	VK4ANR	1550
	Glenn McNeil	VK4BG	1633
L	Graeme Dowse	VK4CAG	1417
	Chris Lowe	VK4CL	1651
L	Les McDonald	VK4CLF	961*
L	Norm Phillips	VK4CNP	1015+
L	Jon Walton	VK4CY	842*
L	Ian Browne	VK4DB	1283
	Dale McCarthy	VK4DMC	1465

	Name	Call	No
L	Merv Deakin	VK4DV	1230*
	Ron Goodhew	VK4EMF	1516
	Ron Kerle	VK4EN	1706
	Bob Lees	VK4ER	1609*
	Jim Downman	VK4FAD	1659
	Len Eaton	VK4FIAA	1606
	Felix Scerri	VK4FUQ	1533
L	Geoff Bonney	VK4GI	969*
L	Warren Heaton	VK4GT	672*
	Daphne Ayers	VK4IA	1647
	Kevin Dickson	VK4IW	1158
L	Gordon Loveday	VK4KAL	707+
L	Andy Beales	VK4KCS	1579
	Tony Dore	VK4KJD	1737
L	Norman Fiori	VK4LD	1296
	John Horrocks	VK4LJ	1362*
A	Mike Patterson	VK4MIK	1467
L	Mario Antoniutti	VK4MS	1470
	Mike O'Connor	VK4MW	1603
A	Ray Crawford	VK4NH	1653
	Dick Pietrala	VK4OP	1075
	Ian McCosker	VK4PF	1162*
	Allan Downie	VK4QG	1565
	Mike Charteris	VK4QS	1329
L	Rod Rush	VK4RA	1477
	Ron Grandison	VK4RG	668*
L	Ross Ramm	VK4RO	1433*
L	Alex McDonald	VK4TE	1411*
L	John Roberts	VK4TL	1005*
L	Mick McDermott	VK4TMD	1317
L	Paul Blake	VK4TPB	1514
	Victor Stallan	VK4WST	1688*
	Ray Thorn	VK4WY	1724*
L	Chris Bourke	VK4YE	1436
	Nick Watling	VK4YT	1263*
	Frank Adamson	VK4ZAK	1406
	Philip Tomlinson	VK4ZPE	1624*
	Kevin Dibble	VK4ZR	1060
	Bill Wilcock	VK4ZWJ	1373

South Australia

	Name	Call	No
	Mike Hall	VK5AGI	1615
	Kevin Zietz	VK5AKZ	1735
	Peter Reichelt	VK5APR	1612
	Adrian Wallace	VK5AW	1637
	Wolfe Rohde	VK5AXN	1628
	Mal Haskard	VK5BA	1107*
	Lloyd Butler	VK5BR	1495+
	Dick Turpin	VK5BRT	1347
	Barry Williams	VK5BW	1551
	Henry (Curl) Blythe	VK5CL	1654+
L	Brian Condon	VK5CO	291*
	John Drew	VK5DJ	951*
	Mac Macdermott	VK5FLEN	1631
	Jeff Farmer	VK5GF	851
L	Paul Spinks	VK5GX	1214
	Colin Hurst	VK5HI	1716*
	Harro Krause	VK5HK	1275
L	Ian Sutcliffe	VK5IS	1355
	Trevor Niven	VK5NC	946*
L	Keith Metcalf	VK5ND	1537*
	Bryan Scott	VK5NOS	1202

	Name	Call	No
L	John Butler	VK5NX	1120
L	Terry Franklin	VK5OC	1430
	Tony Wilkinson	VK5PBB	1453
A	Ron Zimmermann	VK5PCZ	1449
	David Poole	VK5PL	1729
	Peter Russell	VK5PR	1702*
	Trevor Greig	VK5PTL	1601
	Phil Day	VK5QT	1722
L	Ivan Huser	VK5QV	477*
	Rob Gurr	VK5RG	1500*
L	Ron Coat	VK5RV	1000+
	Colwyn Low	VK5UE	1361*
	Rod Cunningham	VK5UV	1694
	Bill Thomas	VK5VE	1321*
	Ron Holmes	VK5VH	1299+
L	Ian Werfel	VK5VJ	968
A	Lyle Whyatt	VK5WL	1680
	Colin Luke	VK5XY	1168*
	Hans Smit	VK5YX	1517
	Geoff Cleggett	VK5ZAE	1734
	Adrian Waiblinger	VK5ZBR	1614
	Ian Coat	VK5ZIC	1682
	Ian Maxted	VK5ZIM	1562
	Peter Temby	VK5ZJ	1229
L	Peter Whellum	VK5ZPG	1479

Western Australia

	Name	Call	No
	Brian McDonald	VK6ABM	1508*
L	Bob Sutherland	VK6ABS	1483*
	Mark Barnett	VK6ACB	1665
L	Barrie Burns	VK6ADI	1273*
	John Farnan	VK6AFA	1409
	Peter Zwarecz	VK6APZ	1715
L	Mark Bussanich	VK6AR	1334
	Geoff Wood	VK6AT	1721
	Tony Argentino	VK6ATI	1591
	Graeme Smith	VK6ATS	1719
	Anthony Benbow	VK6AXB	1566
L	John Van-Tiel	VK6BCU	1481
	Bob Good	VK6BI	1652
	Richard Grocott	VK6BMW	1555
	Barrie Field	VK6BR	377*
	Dick Roddy	VK6BV-ex	1146
L	Bob Crowe	VK6CG	1405*
B	Ken Taylor	VK6CO	1529
	Clive Wallis	VK6CSW	1289
	Clem Patchett	VK6CW	742*
	Arthur Eder	VK6CY	1303
L	Doug Wells	VK6DEW	1458
	Doug Jackson	VK6DG	1243
	Chris Dodd	VK6DV	1501+
L	Don Newman	VK6EY	1558+
A	Rob Hatton	VK6FX	1708
	Gerry Wild	VK6GW	1112*
	Phil Hartwell	VK6GX	1494
	Bob Howard	VK6HJ	1623*
A	Richard Campbell-Morrison	VK6HRC	1698
A	Wayne Fiddes	VK6HWF	1429
	John Tower	VK6IM	1691
L	Glen Hufner	VK6IQ	1072*
	Peter Scales	VK6IS	1700
L	John Farnell	VK6JF	1297
	Chris James	VK6JI	1587
	Jim Preston	VK6JP	1121
	Keith Bainbridge	VK6KB	1664
A	Dudley Donovan	VK6KBY	1672
	Chris Hill	VK6KCH	1741
	Phil van Leen	VK6KHV	1655
	Kevin Byrne	VK6KQ	1740
L	Bob Lockley	VK6KW	1172
L	Glenn Ogg	VK6KY	1358*
L	Lance Rock	VK6LR	1509*
	Bill Toussaint	VK6LT	1561
	Cliff Bastin	VK6LZ	1310
	Syd O'Neill	VK6MK-ex	1124
	Nick Vitalone	VK6NA	1745
	Lindsay Hirschausen	VK6NO	1714
L	Noel Sanders	VK6NS	1493
L	Alan Gibbs	VK6PG	815*
	Rob Penno	VK6PO	1111*
L	Ray Peterson	VK6PW	346*
L	Phil Zeid	VK6PZ	752+
	Peter Walton	VK6QK	1627
L	Graham Rogers	VK6RO	1302
L	Ron Collier	VK6RT	1440+
	Geoff Matthews	VK6SI	1738
L	Phillip Bussanich	VK6SO	1247
	Don Truscott	VK6UT	1212
	Wayne Jefferies	VK6VE	1731
A	Duncan Page	VK6VO	1340
	Steve Ireland	VK6VZ	1690
	Bill Rose	VK6WJ	1463
	John Tuppen	VK6XJ	1525
L	Roy Watkins	VK6XV	1181
L	Poppy Bradshaw	VK6YF	1191+
	Trevor Dawson	VK6YJ	1662
	Peter Savage	VK6YV	1671
	Tom Berg	VK6ZAF	1133*
	Max Shooter	VK6ZER	1431*
L	Igor Iskra	VK6ZFG	1559*
L	Phil Casper	VK6ZKO	1445
	Christine Bastin	VK6ZLZ	1311
	Robert Randall	VK6ZRT	1225

Tasmania

	Name	Call	No
	Allen Burke	VK7AN	1270
	Tony Bedelph	VK7AX	1676
	Frank Beech	VK7BC	1522*
L	Nicholas Chantler AM	VK7BEE	1538
	Anne Landers	VK7BYL	1439
	Doug Charlton	VK7DK	1050*
	Mike Hawkins	VK7DMH	1597
	Jerry Smutny	VK7EE	1595
	Winston Nickols	VK7EM	899*
	Tom Moore	VK7FM	1593+
L	Herman Westerhof	VK7HW	1604
	Chris Holliday	VK7JU	1667
	Reg Emmett	VK7KK	1709*
L	Charles Spiegel	VK7KS-ex	660*
	Bob Geeves	VK7KZ	907*
B	Ross Broomhall	VK7LH	1699
L	Rex Moncur	VK7MO	1298*
L	William Maxwell	VK7MX	1418
	Bill Dixon	VK7OZ	1710*
L	Peter Dowde	VK7PD	1554*
	Bob Reid	VK7RF	1666*
L	Richard Rogers	VK7RO	908*
	Trevor Briggs	VK7TB	1316
L	Justin Giles-Clark	VK7TW	1712
L	Winston Henry	VK7WH	1526*
A	Wayne Hardman	VK7XGW	1723
	André Bochenek	VK7ZAB	1725
L	Paul Edwards	VK7ZAS	1324*
	Idris Rees	VK7ZIR	1713
	John Jongbloed	VK7ZJJ	1584
L	Mike Alsop	VK8MA	1743*
	Peter Clee	VK8ZZ	1728

Overseas

	Name	Call	No
	David Dunn	G3SCD	1252*
L	Ira Lipton	WA2OAX	1344*
L	Martyn Seay	ZL3CK	1159

Membership statistics

191	Life members
264	Full members
5	Associate Life members
19	Associate members
479	**Total membership**

including

126	Licensed 50 years or more
27	Aged 90 years or more

ar

New RAOTC members

It is with pleasure that we record and welcome the following new RAOTC members:

Name		Call	No	Gd
Geoff	Matthews	VK6SI	1738	F
Terry	Stewart	VK4AAT	1739	F
Kevin	Byrne	VK6KQ	1740	F
Chris	Hill	VK6KCH	1741	F
Helmut	Inhoven	VK3DHI	1742	F
Mike	Alsop	VK8MA	1743	L
Jim	Goding	VK3DM	1744	F
Nick	Vitalone	VK6NA	1745	F
John	Cheeseman	VK3XM	1746	F
David	Swallow	VK3AWX	1747	F

ar

Obituary

Joseph Eric Gelston VK7JG

RAOTC member No 1101

20th July 1945 – 29th May 2018

I regret to advise that on 29th May 2018 Joseph Eric Gelston, better known as 'Joe', lost his battle with lung cancer. Joe was first licensed in 1965 with the call sign VK7ZGJ. He took up employment in Port Kembla in 1966 where he acquired the call sign VK2ZGN.

On moving back to Tasmania a couple of years later, he advanced to the call sign VK7JG while working for AWA Communications Division. He later started his own business, Gelston Communications.

Joe occupied various positions in the local radio club and the WIA Tasmanian Division. Many will remember him as a Federal Councillor. He was later honoured with WIA Life Membership.

Joe's special interest was in VHF/UHF weak signal work where he helped pioneer some of the digital modes, particularly for EME. Rex VK7MO told me that Joe was his inspiration for rekindling an interest in amateur radio upon retirement.

Joe worked tirelessly to build and maintain many of the beacons and repeater stations in VK7 up until a few months prior to his death.

I've been told he wanted his ashes scattered on Mount Arthur, adjacent to where he spent so much time developing the site for amateur and commercial repeaters.

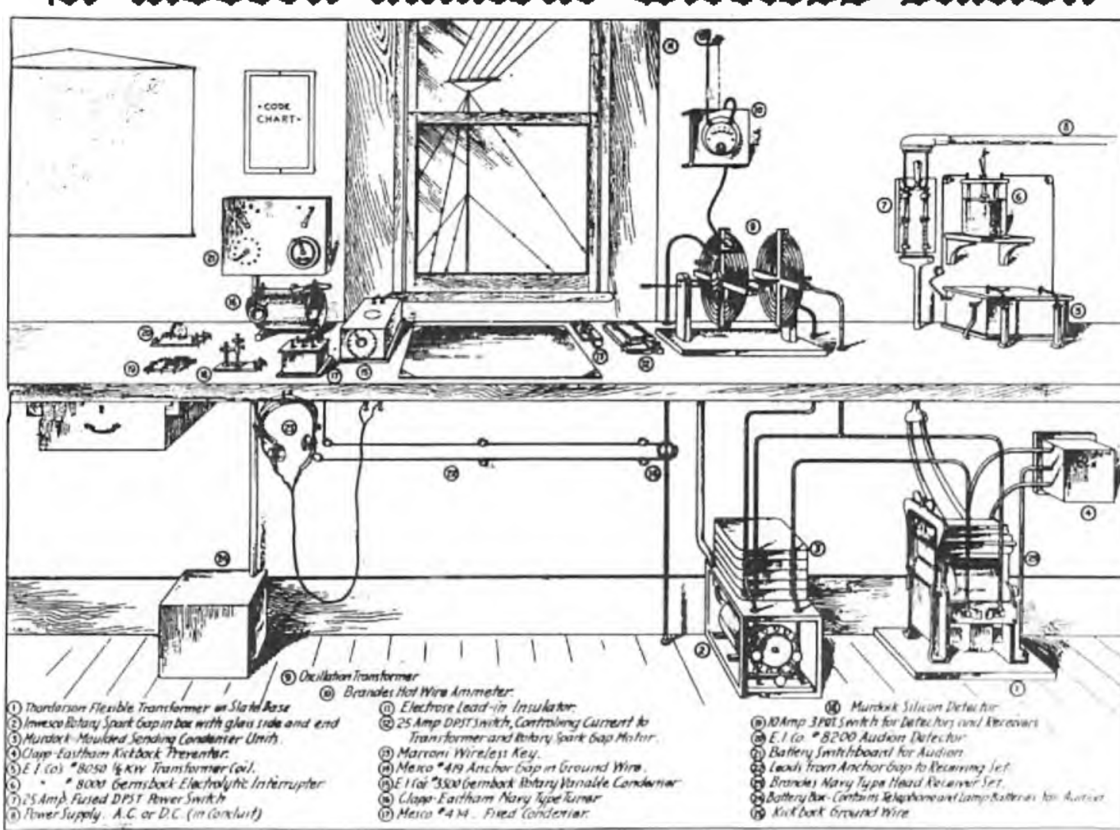
Joe is survived by his widow Phyl, daughter Charmaine, son Chris, and granddaughters Zoe and Eveey.

Vale Joe.

Peter Dowde VK7PD
RAOTC member No 1554

ar

A modern amateur wireless station



The above drawing of a radio station circa 1912 was sent to the late Alan Doble VK3AMD from an amateur in the UK many years ago. Alan passed it on to Ken Morgan VK3CEK who recently sent it along to Bruce Bathols VK3UV who sent it along to *OTN*.

ar

The trials and tribulations of a marine radioman

Herman Willemsen ex-VK2IXV
RAOTC member No 1384

A fellow RAOTC member asked me what life was like as a Radio Officer on board a ship. I can only speak from my own experience as an RO on Dutch merchant ships. Here is my story.

To start with I spent two years learning radio theory, and how to send and receive Morse code, at the Radio-Holland College in Amsterdam, and then six months of practical repair and maintenance tuition on shipboard radio-room and wheelhouse equipment at the Radio-Holland premises in Rotterdam.

Finally the day came to be examined by the Director of Posts Telegraphs and Telephones (PTT) in The Hague. I passed and obtained my Dutch radio certificate. I saw it as my passport to see the world. This certificate was recognised by many other countries and a number of my classmates went to serve on Greek ships and on Israeli ZIM line ships.

The Radio-Holland Marconists class of 1959.

We were called Marconists (after the inventor of wireless telegraphy Guglielmo Marconi), Radio Officer (RO), Wireless Operator, Vonkenboer (Sparkfarmer), Sparks or even Draad (Wire).

In his book *Captain Jan* (Dutch title is *Hollands Glorie*) the Dutch writer Jan de Hartog[1] portrays the RO on a seagoing tugboat as follows: "*...as a pale, pimply man who lives in his radio room on the bridge deck with the passionate seclusion of a hermit.*

"He is a stranger on board who originates from a radio-institute in Holland and is especially mustered for this voyage. He considers himself an outsider of a better social class who ignores the crew, which suits them fine. However, the officers have to put up with him three times a day, when he, wrapped up in his green and purple chequered dressing gown, descends to the mess-room at meal times. The men at the table the RO joins become not very comfortable, because the RO's conversations are unpleasant since he spouts all sorts of cultural bunkum. After having complained about the glassy spuds and the tough meat, and showing off his skills with fork and knife, everyone is happy when he finally leaves. As a whole, they leave him in peace in his mysterious laboratory full of cylinders, curling rods and confusing wires, where strange soft lights glow when he receives and blue sparks crackle when he transmits. No one has the faintest idea what he is doing. He is the ship's magician and cannot tolerate spectators in his laboratory."

And in another book, *A Sailor's Life*, Jan de Hartog writes about the RO on board in this way:

"They are the most recent addition to the ship's crew and show the characteristics of the youngest member of the family. They don't quite fit into the community to which they have been added and that is perhaps why they are still suspected of not pulling their weight.

Of course, the wireless-operator, or as he should officially be called, radio officer, is one of the most important members of the crew as he establishes the link between the ship and the rest of the world. He is very conscious of the rest of the world and consequently feels a bit of an outsider.

He also feels, and this is where the trouble lies, slightly superior ... wireless-operators do not keep watches but lead an independent existence in a private little cubicle on the boat deck ... the only person able to judge whether a wireless-operator is testing or resting is another wireless-operator ...".

Jan de Hartog, in my view, uses a fair degree of 'artistic freedom', which he was entitled to. However, some of it is close to the bone, though. But, allow me to tell you the real story from my point of view, including my comments on de Hartog's characterisation of an RO.

It was not long after I obtained my radio certificate that my employer Radio-Holland posted me as the Third RO on the passenger ship *Groote Beer* of the Holland-America-Line (HAL) Rotterdam.

This ship was an interesting start to my career. The *Groote Beer* started her working life in 1944 as a Victory type ship named *Costa Rica Victory*. In 1952 additional decks were added to the ship and, in order to provide adequate stability, extra ballast was put into her bottom. And that is how this wartime convoy ship became a passenger ship.

SS *Groote Beer*.

When the Dutch government bought her in 1947, she was renamed *Groote Beer*. She could accommodate 800 passengers. It was a 'stiff' ship, which meant that when she rolled in bad weather she tended to snap herself back upright very quickly. Hearsay was that too much ballast, in the form of concrete, had been poured into her bottom during her transformation. For the passengers this was not very comfortable and neither was it for me, but more on that later.

In 1961 I made several voyages on the *Groote Beer*. She transported passengers and American exchange students from the 'Study abroad Program' between New York and Rotterdam. It was nothing more than a milk run. The duration of this Atlantic Ocean crossing was about 10 days, depending on the weather.

As assistant or Third RO, my two four-hour watches were from 1200-1600 and 0000-0400 hours. In the afternoon I often stood behind the counter of the radio room where passengers could lodge their telegrams. These telegrams were transmitted via wireless telegraphy to destinations anywhere in the world. At night I had to receive the shore-to-ship wireless telegraphy news (the Press), listen to the emergency radio frequencies, add and correct information to the six volumes of *Admiralty List of Radio Signals*, and much more.

Sometimes I tried to make contact with American Coast Radio Stations, but that was a risky business because the sleeping quarters of the Second RO was next to the radio-room. In the beginning he did not really like me to touch the radio equipment at all.

Daily, the latest local and world news was received via the Dutch Coast Radio Station Scheveningen Radio/PCH[2] in Dutch and from other Coast Radio Stations in English. At 2345 hours I was shaken awake by a sailor-on-duty. After I dressed I went straight to the radio-room where the Second RO sat in his chair with his headphones on receiving the Press which he typed directly on to an A4 sheet in his typewriter. As soon as I appeared, he put the headphones on my head and pushed the chair towards me so that I could continue typing the news.

The Dutch Coast Radio Station Scheveningen Radio/PCH

For a young and inexperienced assistant RO this was, in the beginning, no easy task. The news entered my headphones in the form of fast Morse code signals, mixed with QRN and QRM. It was very easy to miss words or even a whole sentence. When I lost my concentration, even for a few seconds, I started to miss letters so that some of the long unfamiliar surnames of foreign dignitaries were received distorted. I can still hear the Chief RO saying, "Just as well we bought the latest edition of *Times* and *Newsweek* while ashore, otherwise we would have never known who they were talking about".

Early each morning the Dutch ship's newspaper called *Ocean Post*, plus a small English newssheet for the foreign passengers, was printed and distributed by me throughout the ship. In this way everyone stayed up-to-date with the latest domestic and world news.

Inside the Dutch Coast Radio Station PCH.

During one of those Atlantic Ocean crossings the ship hit the tail end of a cyclone. The ship rolled and pitched heavily. When I received my usual wake-up call at 2345, the first thing I did was to put on my glasses. I wanted to get out of my bunk, which was situated at the starboard (right) side of the ship, but at that moment the ship rolled heavily to starboard and I was pressed against the wall of my bunk and unable to move. The ship then suddenly and quickly raised herself. I shot out of my bunk like a bullet and smashed my face and glasses against the opposite wall.

My glasses were broken and I had to put up with short-sightedness for the rest of the voyage!

My second ship as assistant, and this time Second RO, was on the passenger ship *Prins der Nederlanden* of the KNSM (Royal Dutch Steamship Company), Amsterdam. She was a diesel powered ship, only three years old and she looked splendid. She could accommodate 184 passengers. She sailed the regular service of Amsterdam - Southampton - Barbados - Trinidad - Curacao - Aruba - Suriname. In other words, a dream cruise.

My boss, the Chief RO, whose name I have forgotten long ago, was an unsociable man and a workaholic. He was a good tradesman and a competent Morse code sender but he did not like people and was happiest when stuck in his radio-room. I was not allowed to even touch the radio equipment, but had to represent him at social occasions on the ship.

On my first day he gave me a pile of lists, issued by the Ministry of the Navy, with corrections and additions to the *Admiralty Lists of Radio Signals* for coast and ship radio stations. I was sure it would take me many months to finish all the paperwork. It was tedious and frustrating work, and in the meantime I was not learning a thing about the radio-room equipment and the daily work of a Marine RO. I became so fed up with all the parties and paperwork that one day I confronted my boss. To my surprise he took notice and I was allowed, albeit under his strict supervision, to send and receive radio telegrams to and from PCH.

When this went reasonably well, he did not have any reason to keep me out of the radio-room, but he remained a nervous and difficult-to-approach person. He actually reminded me of the RO on the ocean-going tugboat in the book *Captain Jan* mentioned above.

When the ship returned to Amsterdam I was due for leave. I went to stay with my parents in Holland and lazed around until Radio-Holland found me another ship. Luckily this happened sooner than I expected.

This time Radio-Holland asked me to join a ship for a short coastal voyage Rotterdam - Hamburg - Antwerpen - Rotterdam. I can't remember the name of this old ship. My colleague, whom I relieved, had just returned from a voyage to the tropics and he looked very suntanned. He was glad to go on leave and as quickly as possible handed me the necessary paperwork to sign.

More often than not the weather in the North Sea is bad and this time was no exception. As soon as the ship entered the open sea near the Hook of Holland, I became seasick, but I had to stay on duty so that I could provide weather forecasts and 'Notices to Mariners' to the Captain.

The next day I felt much better, but now my body itched all over. My cabin steward, when servicing my room, noticed me scratching and said that my itch was most likely due to bed lice and that he would arrange for a clean mattress. That certainly made a difference and the next day the itch had gone.

After this short coastal journey I was asked to make two more short relief-voyages on ships whose names I have since forgotten.

Inexperienced Radio Officers, like me, were often assigned to those short coastal voyages. You were the only RO on board, so you had to take complete responsibility for the radio-room and through this you quickly learned to stand on our own two feet.

After my coastal spell, Radio-Holland notified me that in two weeks I had to join my next ship the *Stad Dordrecht*. This ship was a total rust bucket, but a rookie's delight.

SS *Stad Dordrecht*.

She was a Liberty-class ship, with a carrying capacity of 4,564 deadweight tons, of the shipping company Halcyon Line (HL) Rotterdam. Her route was Rotterdam - Spain - Italy. Her cargo was either coal or silver sand, which is fine-grained, white, extremely pure sand that is rich in quartz and is used in high-quality glass industries and the making of gravestones.

The capital letters HL of the shipping company were clearly visible on her funnel. According to the crew, HL stood for 'Hunger Line', but I thought that the food on board was not too bad at all. Maybe we had struck a better cook. The crew on this ship was Spanish. The chief cook, the boatswain, the deck officers, the engineer officers and the RO (me) were all Dutch.

The Spaniards were competent sailors who did not drink too much, never got into a fight and did not spend much money ashore. They worked on ships to save money. There was always someone amongst the Spanish crew with barber skills who could give you, for a few Dutch guilders, a decent haircut. The only Spanish I can remember is: "Mucho trabajo y poco plata",[3] which I learned from the Spanish sailors.

On this Liberty ship my accommodation, which on most ships was situated next to the radio-room, was one deck below the radio-room. This was rather inconvenient, especially when the Auto Alarm bell in my cabin went off and I had to rush to the radio-room. My cabin was small but comfortable with a round porthole and a hot water radiator, which was on because it was winter.

The inner side of my bunk bed was up against the metal ship's hull and very cold and damp because it was only separated from the water by about 1 cm of steel plating. In the beginning I often ended up in the morning as stiff as a board and half frozen because I had been lying against this cold hull. To stop this from happening I hung a thick coarse blanket between the hull and my mattress, which worked fine.

In Spain we did a bit of wheeling and dealing with the dock workers. We exchanged our Dutch 'Rennie' indigestion and heartburn tablets for the Spanish 'Gabon Maja' soap which was not for sale in Holland and therefore extremely popular amongst my friends and family members. This soap came in a black wrapper with the lady dressed in red, waving a fan. Apparently good antacid tablets were hard to get in Spain.

I will never forget the day when the Dutch chief cook of the *Stad Dordrecht* handed me a telegram which contained rather abusive words directed towards his spouse. I told him that I was not allowed to send this and could he please alter his wording. He blew a fuse and stormed out of my radio-room shouting that his job was to cook the bloody meals and it was my job to send bloody telegrams. I went to the Captain for advice. After reading the text he tore the message into bits and threw it in the bin. For me this meant a trip to the galley to refund the cook his money and tell him the bad news. He was not amused and I couldn't get out of the galley fast enough.

My next ship was the *Medon*, again from the company KNSM. She visited the West Indian islands Aruba, Bonaire and Curacao and also La Guaira in Venezuela, Paramaribo in Suriname and Port-au-Prince in Haiti. From there the ship would go on to a couple of ports on the east coast of the United States. Just as the Halcyon Line (HL) was known as the Hunger Line, the nickname for the shipping company KNSM was 'Kan Niet Slechter Meer', which in English means 'Can't get any worse', referring to the poor food on board.

SS *Medon* of the KSNM Line.

I actually found the meals on board quite good. This was the routine at lunchtime: after first drinking an aperitif, accompanied by savoury appetisers, the Captain, the First Officer, the Chief Engineer and the Chief Steward went to lunch. The lower ranked officers, me included, ate at the second sitting. I believe that the menu of the 'Top Brass' was better and more lavish than ours, but I had no reason to complain about our food.

The only thing I found a bit peculiar was that we had to ask the Second Engineer Officer, who acted as the head of our table, when we wanted a second helping of meat or vegetables. After all we were young and always hungry.

After the *Medon*, I went on leave in the Netherlands, but I soon became bored.

When at long last Radio-Holland called me, it was mid-winter, slippery, cold and abominable weather. This time I had to join the *Tjibodas*, a ship of the Koninklijke Java-China-Paketvaart Lijnen (KJCPL), better known outside the Netherlands as the Royal Interocean Lines (RIL).

Sailing on RIL ships meant that I would not be back in Holland for two years. I had no problem with that.

With Hong Kong as Head Office and Singapore as our homeport, the RIL maintained regular shipping services to ports in the Far East, Australia, Africa, India, the Philippines, Japan and South-America. "Wow", I thought, "the Far East, plenty of sunshine, it could not be better!!"

I did two 2-year terms in the tropics and loved every minute of it. I sailed respectively on RIL ships *Tjibodas*, *Straat Banka*, *Straat Cumberland* and *Straat Lombok*. I have written stories about the *Stad Dordrecht* and *Tjibodas* in previous issues of *OTN Journal*.

The *Straat Banka* was a cargo ship with accommodation for 46 passengers and had, as was required by company law, a qualified doctor on board.

MS *Straat Banka*.

When I boarded her in Singapore I knew that this ship had a complement of two ROs, a senior and a junior one, with me being the senior one. Somehow I forgot to ask, or Radio-Holland forgot to tell me, that this was no longer the case. Once on board, I went straight to the cabin next to the radio-room with a clear sign "2e Marconist" above the door. Excellent, I thought, I have an assistant on board. I'd better introduce myself.

However, when I opened the door all I saw was a Chinese girl in a state of undress. When she saw this Dutch barbarian she screamed in fright. That was certainly an unusual way of finding out that this ship no longer carried two ROs. This cabin was now occupied by a Chinese stewardess, who was there to attend to the passengers. For the remainder of the voyage she sneaked, like a frightened rabbit, past my radio-room, ignoring me completely.

Another event I remember is when the *Straat Banka* was approaching Mauritius. It was 22nd November 1963 and I had just received the news that President Kennedy had been assassinated. I immediately informed the Captain.

As we had a handful of American passengers on board, the Captain asked me to get as much coverage as possible, which I did. I even tuned in to other Coast Radio Stations sending Press bulletins of which Radio-Holland was not a subscriber. But who cared, this was major news.

I served only four months on the *Straat Banka* and just as well, as I was not getting enough sleep. The reason was that my sleeping quarters were next to the bridge. Therefore, when a navigation officer finished his watch at 0000, he knocked on my door, asking me to have a chat and a drink with him. How could I refuse? I usually went back to bed about 0200 until the next officer came off duty at 0400. Another talk and another drink and back to bed, hopefully before 0600. Then breakfast at 0700 before going on duty at 0800. How good is it to be young!

•Jan de Hartog wrote of the ship's RO as, "*Pale, pimply, a hermit*". Here are my comments on that description.

Like me, the RO on a freighter was usually a young man wearing glasses. And I remember clearly a day in the 1960s when I was on duty in my radio room on the Victory ship *Tjibodas* in the tropics with only my shorts on and a towel on the back of my chair. Because of the tropical heat outside, the lack of air conditioning, only one porthole in the metal radio-room, plus the extra heat generated by the receivers, transmitters, the DC-AC converter under the desk at my feet and the big resistances of the battery loading device in the RCA 4U radio console nearby, the heat and humidity of the radio-room was reaching sauna room levels. On that day the Captain, on entering my radio-room, said that he did not like the look of my spotty back and that I should not forget to put my full uniform on when going down for meals.

The RCA 4U radio console.

The writer calling the RO pale is in my view a degree of poetic licence, as I can find no reason for an RO to be paler looking than the rest of the crew. Being a hermit is also a bit of an overstatement. In general ROs did not lock themselves up in their radio-room, especially not in the pre-aircon days. On the freighters I sailed on, the radio-room was open for public access for eight hours per day during which the officers, crew and passengers could lodge their telegrams.

The Captain, of course, could ask me to send a telegram any time of the day. An RO on a freighter was on duty eight hours per day, two hours on, two hours off, thus spanning 16 hours. Watches at sea were kept in GMT times and, depending on the ship's longitude, at a local time between 8.00 am and midnight.

When off duty, the watch keeping on the international calling and distress frequency of 500 kHz was taken over electronically by the Auto Alarm (AA)

MV *Straat Cumberland*.

receiver, a TRF receiver fixed tuned on 500 kHz and powered from the 24 VDC ship's batteries. It would react to the international radiotelegraphy signal, which consisted of a series of 12 x 4-second dashes.

The purpose of this special signal was the actuation of the ship's AA. Alarm bells would ring noisily on the bridge, the radio-room and the sleeping quarters of the RO.

Mind you, the AA would often, too often, go off during heavy QRN. You can imagine that it would drive me, but especially the officer on the bridge, crazy and for that reason it was common practice to put a big bit of rubber around the clapper of the electromagnetic bell on the bridge. This rubber bit was, of course, temporarily removed when the ship was visited by a Radio Inspector.

•Jan de Hartog wrote, "*The RO is a stranger on board, of better social class and ignores the crew*".

Although I sailed with Dutch and Spanish crews, I mainly sailed with Hong Kong Chinese crew and they were fine. They invited us to their parties below decks and they did not cause any trouble as long as they could do their own thing, eat their own food and they were allowed to make a bit of extra money on the side. I have consumed many near-raw and spicy chicken morsels during their Gong Hey Fat Choy. In my free time I used to do repairs on their domestic radios and on the walkie-talkies of the deck officers.

The Dutch officers came from all walks of life and got on well together on board the ship. We relied on each other, met each other over meal times or had a drink together in my cabin or in a cabin of an off-duty engineer or deck officer. When the ship was alongside we went ashore together.

The only thing I can say is that the RO was the man from Radio-Holland, the company that installed and maintained radio equipment on board ships and was the employer of radio officers for Dutch ships. All the others belonged to the ship's shipping company. However, nobody seemed to worry about this. We were all in the same boat so to speak.

•Jan de Hartog wrote, "*The RO complains about the glassy spuds and tough meat and showed off his skills eating with fork and knife*".

Yes, the younger officers, not the RO only, sometimes complained about the tough meat. I remember once that after the meal we literally took our complaint to the Captain. He simply pulled a razor sharp knife out of his drawer and cut the steak. "Nothing wrong with it", he said. That was that! In the main, the meals on board were plentiful and tasty.

We all ate with fork and knife, or with chopsticks when on Chinese crewed ships.

On RIL ships the RO sat at the Second Officer's table. I always felt accepted and never an outsider. During mealtimes we talked about all sort of subjects, although religion, politics and sex were supposed to be taboo subjects, nevertheless often discussed.

•Jan de Hartog wrote, "*ROs keep irregular watch hours. Was he testing or resting?*"

When on duty, the tasks of an RO were many and varied. Below I go into a bit more detail:

1. The RO's main duty was SOLAS (Safety Of life At Sea), by listening 24 hours to the international calling and distress frequency of 500 kHz. The 24 hours was covered by the RO and the Auto Alarm apparatus. Depending on the ship and the number of ROs, a radio-room watch was kept for 8, 16 or 24 hours. Ships with one RO kept aural watch for eight hours.

During the watch special attention was given twice per hour between 15-18 and 45-48 minutes on the GMT clock. This was to improve the reception of any weak telegraphic distress signals. During these 3-minute periods, called Silence Periods[4], it was forbidden worldwide to transmit on 500 kHz.

2. Receiving relevant weather bulletins and navigational warnings.

3. Receiving the traffic lists of not only the Dutch coast radio station PCH in the Netherlands, but also of countries of departure, destination and origin of passengers.

By the way, a traffic list, sent by a Coast Radio Station in Morse code, is a list of ship's radio callsigns in alphabetical order for which there are telegrams on hand. If your ship was in the list you had to make contact with the Coast Radio Station on the right frequency. This could take a while.

I understand that PCH was the only Coast Radio Station in the world which had a Unilateral Transmission system. This meant that, even when a Dutch ship was in port where transmitting was not allowed, the ship could still receive its messages. The ship had to apply for this privilege with PCH and tell them how long your ship would be in port. QSL of the message would be given to PCH after leaving port.

4. Receiving the daily newspaper bulletin from the Dutch National Press Bureau via PCH.

Touch typing skills were a must, as the RO typed the Morse coded Press signals, received through headphones, straight onto an A4 page on his typewriter. If there were overseas passengers on board, he also copied the English newspaper report, for instance, from Portisheadradio/GKA.

On ships with Dutch crew, the RO still had to take the Dutch Press when the ship was alongside in an overseas port because everybody wanted the football results. No room for error there!

5. Daily we had to send the ship's position to PCH for the Ministry of Defence and the Dutch newspapers.

6. Taking a daily Time Signal from WWVH for the chronometers on the bridge and the radio-room GMT clock.

7. Sending and receiving telegrams for Captain, crew and passengers on ships with telegraphy only.

On my relief duties in the North Sea I sailed on ships with radio telephony. This meant that the Dutch crews, before arriving in Amsterdam or Rotterdam, wished to alert their loved ones. I took their bookings and money, and arranged a suitable time with PCH. Then I told the crew to come at such and such a time.

I usually had a queue out the door of the radio-room, all awaiting their turn and listening in to private conversations of the others. Their comments were often hilarious.

The author relaxing in his cabin on the *Straat Cumberland*.

8. At all times I had to keep my radio logbook in order and report in there everything that happened during my watch. This log had to be signed by the Captain on a daily basis.
9. Testing equipment such as the Auto Alarm receiver and sender.
10. If a crew member or passenger became seriously ill on board, the RO could be asked by the Captain to send a Radio Medical. It happened to me once en route from Perth to Cape Town on the *Straat Cumberland*. A South African female passenger became seriously ill. I sent the telegraphic Urgency signal XXX (x 3) followed by the ship's radio callsign PHTZ (x 3) and 'need immediate medical advice'. PCH immediately responded and asked me to standby.

My telegraphic message was patched through by PCH to a hospital doctor and I soon received a reply. Just to make sure, I also called IRM, the dedicated Radio Medical Coast Station in Italy. Soon I received their reply as well. However, the Dutch doctor and the Italian doctor had given different diagnosis. The Captain, in his wisdom, decided to sail on as we were soon to arrive in Cape Town. Luckily the female patient's condition improved.

By the way, every ship has a well equipped Medical Chest on board. Although the ship's master is responsible for managing medical supplies kept on board, he may delegate responsibility for their use and maintenance to a properly trained crew member, usually the Second Officer. Nevertheless, although having received a very basic training at a Dutch Hospital, the Second Officer was certainly not medically qualified.

Further activities of the RO, often during his two hour break, were:
11. Take bearings with the radio direction finder (RDF), situated in the chartroom.
12. Maintenance and sometimes repairs of the RDF and its aerial, the echo sounder and radar on the bridge, the central Antenna System for the ship's music equipment. I recall that the RCA CR-103 radar on Victory ships, like the *Tjibodas*, was quite temperamental and went through many fuses. It consisted of many valves and its seven inch high-definition flat-face cathode-ray tube produced a luminous image on a fluorescent screen. It used a fixed frequency X-band Magnetron 725A, which transmitted on wavelength of 3.2 cm, which is a frequency of 9,375 MHz (X-band) and picked up objects between 68 metres and 20 nm (37 km). It had a 60 kW Tx and a low-noise, supersensitive Rx.
13. Maintenance of the main and emergency aerials and their insulators. On the Liberty ship *Stad Dordrecht* the Bosun often had to lower the extremely heavy brass main aerial so that I could wash the salt off the huge porcelain insulators with fresh water. Too much salt and the aerial would short circuit.
14. Maintenance of the batteries, which were part of the emergency equipment. These batteries were either in a well-ventilated locker inside the radio room or in a deck locker close by. Weekly, the acid level and specific gravity of the batteries were required to be tested and the result put into the battery report. Especially in the tropics, an RO used a lot of distilled water.
15. Checking the carbon brushes of the radar aerial motor and making sure that no water was sloshing around inside the 7 ft (2.1 m) fibre glass case covering the radar scanner.
16. Testing of the heavy portable lifeboat transmitter.
17. If requested, repairs to radios or tape recorders of people on board. The Chinese crew especially made use of this.
18. Doing some typing work for the Captain, when requested.
19. When in port, posting letters for fellow officers on duty on board.

•Jan de Hartog also wrote that the RO "*is one of the most important members of the crew*".

By International Maritime law a ship could sail without a Captain but not without an RO. The RO contributed on a large scale to the safety of navigation of the ship by receiving weather forecasts, cyclone warnings and navigational warnings. He was basically the eyes and ears of the Captain.

If a ship was in distress, the RO was there to request urgent assistance. A good example is the *Titanic* disaster in April 1912. More than 1,500 people died but, thanks to wireless telegraphy, the newest communications technology at that time, more than 700 survived.

Furthermore, when somebody on board was ill, the RO would arrange for medical advice.

The RO also kept the crew in contact with their loved ones ashore.

Yes, you could say that he was a very, if not the most, important member of the crew.

Unfortunately, Morse code for ships at sea officially went out of use on 1st February 1999, when the new SOLAS, called GMDSS[5] took over.

RIP the Marine RO.

Acknowledgement

Arie van de Ruit, fellow Marconist, Radio-Holland.

Footnotes

1. Jan de Hartog (1914 - 2002) was a Dutch playwright, novelist and occasional social critic who moved to the United States in the early 1960s and became a Quaker. He died in Houston, Texas, aged 88.
2. PCH commenced in 1904 with radio callsign SCH. From 1913 to its closure in 1999 its radio callsign was PCH.
3. Lots of work for little money.
4. On ships with radio telephony the additional telephone Silence Periods observed on 2,182 kHz were twice hourly between 00-03 and 30-33 minutes on the GMT clock.
5. GMDSS is the Global Maritime Distress and Safety System which uses improved terrestrial and satellite technology. It replaced the SOLAS as I knew it and meant the end of the profession of Marine RO.

ar

More trials and tribulations of a marine radioman

Herman Willemsen ex-VK2IXV
RAOTC member No 1384

Even in the tropics it is not always sunshine and smooth sailing. This story is about the radio duties as performed by my friend and former colleague John Papenhuyzen when he served as Radio Officer (RO) on board the disabled Dutch Royal Interocean Lines (RIL) vessel MV *Tjibantjet*, aground in Hong Kong Harbour in 1957.

The *Tjibantjet* (radio callsign PHZF) was a cargo ship of 8,249 BRT (Bruto Registered Tonnage), built by Bartram & Sons Ltd, in Sunderland, UK and launched in 1951. She was powered by a 6-cylinder Doxford Diesel of 6,800 HP and capable of doing 16 knots. The radioroom installation was an RCA 4U[1].

On 18th September 1957 the vessel departed from Moji, Japan, bound for Hong Kong with an assorted cargo of 4,000 tons. It was a voyage of 1,169 nautical miles (2,165 km). The ship's complement, including the Captain, consisted of a crew of 60 Chinese and 14 Dutch plus six passengers. At the time of departure the weather forecasts made no mention of any disturbances and therefore the normal course to Hong Kong, through the Formosa or Taiwan Strait, was set.

On 20th September the RO received a weather forecast from the Hong Kong Coast Radio Station Cape d'Aquilar/VPS that a tropical depression East of Luzon[2] had developed into a typhoon[3] named 'Gloria'.

On 21st September, at the entrance of Junk Bay, the pilot boarded. The pilot said that the harbour was chock-a-block full with ships. It was then decided to anchor in Junk Bay. Normal sea watches were kept and the engine room was kept on standby.

At about 5.00 pm on 22nd September the wind force had increased to a gale force of 185 km/h with waves of more than 3 m.

It was raining 'cats and dogs' and visibility was poor. Shortly after 6.00 pm the anchors started to drag and the ship was drifting dangerously close towards the rocks despite frantic manoeuvres with the ship's engines.

MV *Tjibantjet*.

The RO, who had gone down to dinner at 6.30 pm, saw through the mess-room windows the rock face getting closer and closer. When he left his table in a hurry on his way to the radio-room, he heard somebody shout, "Sparks.... SOS".

The ship hit the rocks on her portside at Lei u Mum[4] at around 6.45 pm local time (1045 GMT) with the bridge pressed close against the side of the rock. All officers and personnel in the mess-room were suddenly thrown into a heap in a corner of the mess-room, but nobody was seriously injured. At the same time water entered the mess-room.

Having arrived in his radio-room, the RO started the 4U main MF transmitter ET-8024 and sent the automatic telegraphic alarm signal with the 4U Auto Alarm keyer.

Junk Bay is near the eastern mouth of Hong Kong's Victoria Harbour.

Just after the radio-telegraph alarm signal had been sent the ship crashed heavily against the rocks. This caused the main transmit antenna to snap.

The RO retuned the Main MF Tx into the emergency (spare) transmit antenna, not knowing at this stage that the emergency transmit antenna had been covered by broken wires and was therefore partially short-circuited.

However, there was enough output power to send out a distress message.

It was a total mess in the radio-room.

Books, chairs and spare parts were all lying on the low side in the water that had entered through the broken windows and various cracks in the upper deck.

The *Tjibantjet* hard on the rocks in Junk Bay.

The RO could not sit on his chair in front of the 4U because of the steep angle and could only send Morse code by strapping his chair against the office table facing the window and with the 4U on his left side. The cord on the RM-28 Morse key[8] was just long enough for him to hold the Morse key up in the air in his left hand and send with his right hand. Needless to say, there were a few breaks in transmission of the distress message because the RO kept losing his balance when the ship repeatedly slammed against the rocks. But the main thing was that there were radio communications, which became easier when the pounding settled down.

To add to the troubles, the lights went out when the generators in the flooded engine room became waterlogged. As a result, the power to the main transmitter suddenly disappeared, but the emergency generator was quickly started, so that the Main MF Tx could still be used.

When seawater short circuited the wiring inside the 4U console cabinet, sparks and smoke came out of the 4U Main MF Tx and it just died.

However, thanks to the radio station's 12 V battery supply, the 40 W Emergency Tx ET-8025 and the Emergency Rx AR-8610 worked well and the RO finished sending his Distress traffic. However, because of the ship's weak signals, QSO with VPS could only be maintained via the nearby Dutch Shell tanker *Myonia*, radio call sign PGBZ, who acted as a relay station between the *Tjibantjet* and VPS.

This tanker was anchored just around the corner from Lei u Mum Point. Her RO, having initially responded to the radiotelegraph alarm signal from the *Tjibantjet*, remained on duty until he was no longer required.

Another view of the *Tjibantjet* on the rocks.

The next morning, at about 6.00 am, the RO finally got a chance to climb onto the compass deck above the bridge deck and free the wires of a broken stay and the broken main transmit aerial, which had fallen across the antenna inlet. From then on he could make QSO with VPS directly. Telegraphic radio contact was maintained for another week until the 12 V lead acid batteries ran out of capacity.

Although the RO had been very busy sending telegrams regarding the ship's situation, his workload increased dramatically when the shipping company RIL requested hourly SITREPs regarding the general situation on board and the state of the listing.

The radioroom and RCA 4U console on board the MV *Tjibantjet*.

About 11.00 pm the ship stopped rocking and settled down.

At 1.00 am the following morning a connection was made to the shore via a ropeladder and 23 people left the ship, assisted by the harbour police.

Later that morning, around 11.00 am, the rest of the crew and passengers left the ship, except for the Captain, two deck officers, the RO and two engineers.

The RO was never ordered to stay on board. The ship was still manned and had to have radio communication for emergencies, weather reports and telegram traffic to and from RIL's Hong Kong office. He therefore considered it to be his job to stay on board.

After the terror of stranding it was a relief to be alive and be able to stand up, albeit on an angle of 42 degrees. However, it was uncomfortable to stay on his

An RCA RM-28 Morse key with cover as used on the *Tjibantjet*

feet, even on the top deck where the radioroom and his cabin were located.

Strangely enough, the people that stayed behind became used to it and soon settled in. Planking arrived and a makeshift horizontal level platform was made on the deck outside the radio station for them to sit on and to sleep on. The RO, however, found a way to prop himself up on his bed facing the window, putting pillows and blankets under his legs, not quite being horizontal, but better than sleeping outside on the makeshift platform.

Using the toilet or shower was not possible and you have to use your imagination to work out how they got around that one. After four days in this precarious situation the RO was very happy to leave the stricken ship and go to a hotel in Kowloon for the well deserved three 'S's'- a shave and shower being two of them. After a fortnight in the hotel, his services were no longer required and he was sent to the Netherlands on leave.

On 7th May 1958 serious attempts were made to refloat the *Tjibantjet*. Water was pumped out of her flooded holds and leaking holes patched up as well as possible. Then, ever so slowly, the *Tjibantjet* was pulled off the rocks with the help of her own anchors and two tugboats, and towed to a sandy beach on the other side of Junk Bay. After her successful beaching, more repairs were made.

On 20th June 1958 the ship was delivered to a Hong Kong dry dock where 650 tons of steel were used to repair her hull. On 12th and 13th May 1959 technical trial voyages were completed and on 19th May 1959 the vessel departed Hong Kong for her first voyage on the Japan - Hong Kong - Indonesia run. Sad to say that the ship never handled the same as before.

On 16th March 1972 the ship was sold in Buenos Aires to Mercury Shipping Co Ltd, Panama, and renamed *Mercury River*. Her final voyage was on 4th December 1973 when she arrived in Kaoshiung, Taiwan, to be broken up. It was the end of a fine ship.

By the way, after his leave in Holland, John Papenhuyzen returned to sea as RO of the RIL vessel *Straat Johore*. On 25th March 1958, whilst this ship was in the Port of Melbourne, the Dutch Consul there awarded him with a silver 'De Ruyter' medal[6] for his outstanding duties as RO on the *Tjibantjet*.

The Dutch Consul awarding John Papenhuyzen with a silver 'De Ruyter' medal for his outstanding duties as RO on the *Tjibantjet*.

Acknowledgement

Radio-Holland Marine RO John Papenhuyzen.

Footnotes

1. See my story about the 4U emergency Tx RCA ET-8025 on page 47 of *OTN* No 54, September 2014.
2. Luzon is the largest and most populous island in the Philippines.
3. The only difference between a hurricane, a cyclone, and a typhoon is the location where the storm occurs.
4. Also Lei Yue Mun or Lyemun, situated below Devil's Peak, is a short channel in Hong Kong between Junk Bay and Victoria Harbour separating Kowloon and Hong Kong Island.
5. Two RM-28 Morse keys came with the RCA 4U console. They were basically a J-37 key with a cover.
6. The 'De Ruyter' medal was created by Royal Decree in 1907 by Queen Wilhelmina of the Netherlands, to be awarded to those members of the Dutch Merchant fleet who distinguish themselves by praiseworthily acts of duty for the Dutch Ship transport. The medal can be awarded in gold, silver or bronze. Awarding is on the basis of nomination of the Netherlands government and by Royal Decree. With the 'De Ruyter' Medal, the Kingdom of the Netherlands honours since 1907 the 300th birthday of Michiel Adriaansz de Ruyter, one of the most famous admirals in Dutch history.

ar

I'm fine thank you

Not all members of the RAOTC will relate to the following poem sent along by Clive Wallis VK6CSW, but quite a few of us will connect with it.

I'm fine thank you

There is nothing the matter with me.
I'm as healthy as I can be.
I've arthritis in both of my knees
And when I talk, I talk with a wheeze.
My pulse is weak, my blood is thin,
But I'm awfully well for the shape that I'm in.

Arch supports I have for my feet,
Or I wouldn't be able to be on the street.
Sleep is denied me night after night,
But every morning I find I'm alright.
My memory is failing, my head's in a spin
But I'm awfully well for the shape that I'm in.

How do I know that my youth is all spent?
Well, my "get up and go" has got up and went.
But I really don't mind when I think with a grin
Of all the grand places my "get up" has bin.

Old age is golden, I've heard it said
But, sometimes I wonder as I get into bed,
With ears in the drawer, my teeth in a cup,
My eyes on the table until I wake up.
Ere sleep overtakes me, I say to myself,
"Is there anything else I could lay on the shelf?"

I get up each morning and dust off my wits
And pick up the paper to read the 'Obits',
If my name is still missing I know I'm not dead,
So I have a good breakfast and go back to bed!

Anon

ar

Introduction of talking pictures

Lloyd Butler VK5BR
RAOTC member No 1495

In the early years of the nineteenth century, moving pictures shown in halls and theatres were silent. Around 1926, sound was first introduced using transcription discs synchronised to pictures printed on the celluloid film which ran through the projectors. This article focuses on that short era prior to the introduction of sound track to the film. Sitting on that stool in the Bio-Box, all those years ago, little did I realise I was witnessing that short time slot in talking pictures history.

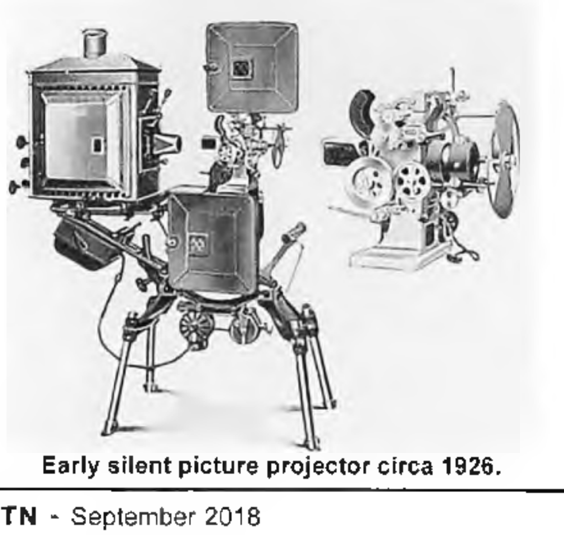
Introduction

At quite an early age I became interested in motion pictures and how the operational projection system developed. Early movies were silent but synchronised sound was developed, initially using analogue techniques which lasted many decades until digital techniques were developed. Movie theatres were established, at first with flat screens, but later optical techniques were developed which led to wide, curved picture displays and even stereoscopic pictures. I will not attempt to get too far into these later techniques. But, as a start, I thought I would concentrate on the era when synchronised sound was initially introduced to the displayed picture. I have discussed further some early advanced sound systems including that used in the road show of *Fantasia*. I have included a section on common film formats including the addition of sound track to film.

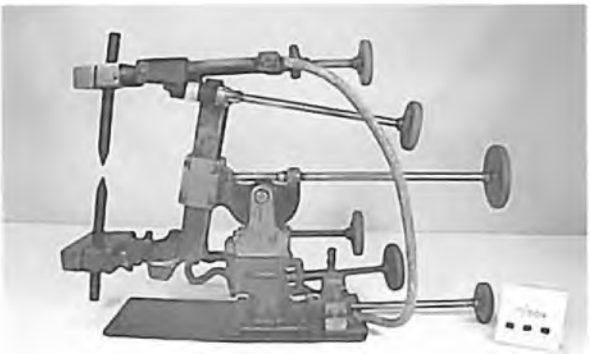
The silent era

Early motion picture projectors projected moving pictures without synchronised sound. During the era of around 1895 to the late 1900s, they were typically located and operated within the theatre auditorium itself. However, by around 1909, due to increasing concerns over the inflammable characteristics of the nitrate film and the safety risks of fire, segregated projection booths were introduced and equipped with fire prevention facility. I remember the days of the movies when they always had a fireman on duty within the theatre.

To project a bright picture on to a large screen required a very high intensity light to be fed through the film frame. For many years the carbon arc was used as the light source. Apart from the high intensity light, it also emitted a high level of radiant heat through the projector aperture. If the film jammed and the heat was allowed to feed through a film frame, the inflammable film very smartly caught fire and this was always the danger requiring safety interlocks to shield the film.



Early silent picture projector circa 1926.



Early carbon arc 1920-1930 era (removed from the projector).

In a carbon arc lamp the electrodes are carbon rods in free air. To ignite the lamp the rods are touched together thus allowing a relatively low voltage to strike the arc. The rods are then slowly drawn apart and electric current heats and maintains an arc across the gap. The tips of the carbon rods are heated and the carbon vaporizes. The carbon vapour in the arc is highly luminous, which is what produces the bright light. The rods are slowly burnt away in use and the distance between them needs to be regularly adjusted in order to maintain the arc. In the photos of the carbon arc and the silent picture projector, the many operator adjustment knobs can be seen protruding from the rear of the arc and the rear of the projector.

Projectors beamed the light image through lenses onto the screen and provided the mechanism to roll the film and switch the changing picture frames through the projector aperture. Properly equipped movie theatres were normally fitted with two projectors so that picture presentation was continuous through changes of film reels. They also had a slide projector to display fixed scene pictures before the start of films and during intermission.

But the silent movies weren't always quiet. Musicians were often engaged to add background music and sometimes their instruments provided live sound to add life to the action being displayed on the screen.

The selection of music depended on who did the choosing. Some musicians tried to incorporate music suitable to the film's setting. For example, authentic sea shanties for a shipboard picture; a bit of Mussorgsky or Rimsky-Korsokov for a Russian setting; or red hot Jazz for a 'flapper' film.

The need for orchestral accompaniment and their musician players led to the development of electric organs, such as the Wurlitzer, which electrically

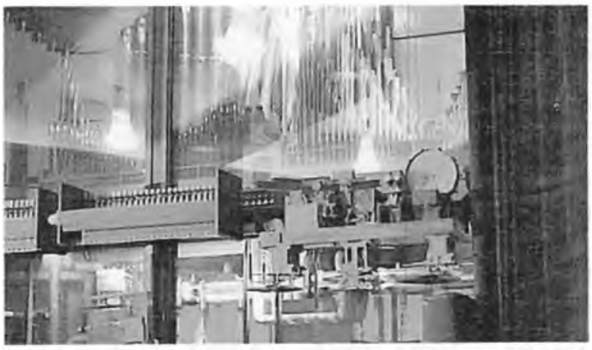
The Grand Regent Theatre in Adelaide had the Wurlitzer Organ (photo 1940s).

operated different instruments all controlled from a single console by a single operator.

In Adelaide, the Regent theatre in Rundle Street was equipped with a Wurlitzer organ. It was a treat to visit the theatre just to listen to the organ at intermission. This magnificent theatre was demolished in 1961 and the organ was moved to St Peter's College where it remains.

The Capri's 'Wurlitzer' Organ was installed by the South Australian division of the Theatre Organ Society of Australia (TOSA) in 1983.

But the electric organ is not lost to Adelaide. The Organ Society of Australia in Adelaide revived what is now the Capri Theatre in Goodwood and retrieved (via Darwin, actually) the Wurlitzer Organ which had previously been in the Plaza Theatre, Melbourne. The



The Capri Theatre Wurlitzer controlled instruments (normally concealed from the theatre audience).

Capri has the remote controlled instruments fitted in the side wings of the auditorium. Covers are normally in place for general use of the theatre but sometimes they remove them so the instruments can be seen. It is intriguing to watch these instruments being played with no human hand in sight.

Synchronised sound on disc

Around 1926, Western Electric introduced sound called Vitaphone to the theatres which used recordings on disc synchronised to the moving picture. The system operated until about 1931 when was it finally phased out by the introduction of sound track on film. Vitaphone was initially very successful in replacing the earlier silent films, particularly with the introduction of *The Jazz Singer* starring Al Jolson.

An early demonstration of projection with the Vitaphone sound on disc in 1926.

The discs, running at $33^1/_3$ rpm on a 16 inch turntable, were synchronised with the speed of the film running through the projector. The operator had to ensure that disc start was initiated to correspond with start of the film on the projector as indicated by cue marks flashed on the screen.

A Vitaphone disc.

It was during this period of sound on disc that I was first introduced to the world of moving pictures. My eldest brother Hurtle was twelve years older than I and was working as an assistant to the operator, Jack Brook, in the Projection Room of the Lyric Theatre at Murray Bridge. Considering the period, I must have been around six or seven years old. One day Hurtle took me up into the projection room and sat me on the operator's stool so I could watch the pictures through the viewing window adjacent to one of the two film projectors. I identify the period because the sound-on-

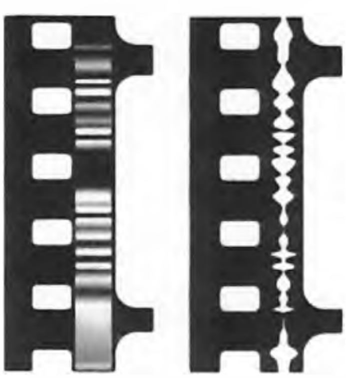
Projection room with sound turntables circa 1928.

disc turntables were in operation. Apart from fear that I might fall from what, to me, was a high stool, I was all eyes and ears to lead me into a new phase of interest in movie pictures. I now realise that I had been shown something of movie sound-on-disc during quite a short time slot in the history of sound in motion pictures.

Sound on film and the sound track

Sound from disc was not to last long. There was always the problem of starting the separate disc so that the sound (and particularly speech) was in precise phase with the moving lips of the performer in the picture. If the film broke and had to be rejoined, the sound would no longer be synchronised beyond the joint. So this led to the sound track printed on the film which automatically synchronised the sound to the pictures framed on the film.

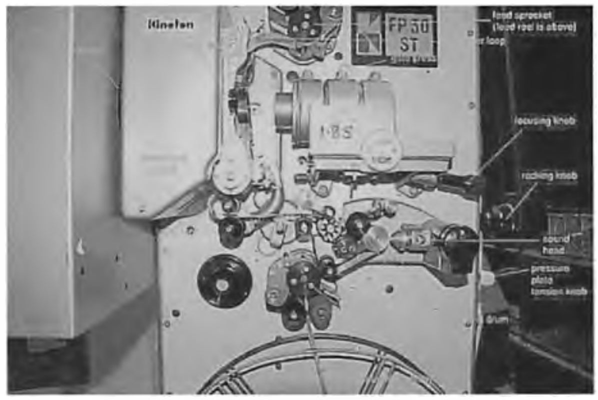
Around 1928, RCA introduced Photophone which provided a photographically formed sound track on the film. In this system, the **print density of the narrow sound track** was varied in proportion to the instantaneous amplitude of the electrical sound wave. By comparison, in later systems **the sound track width** was varied in proportion to the instantaneous amplitude of the electrical sound wave.



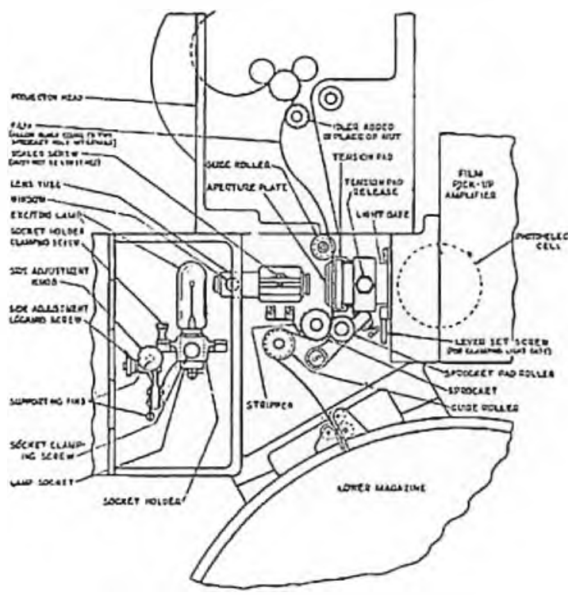
Sound Tracks - Left: Variable Density - Right: Variable Width.

In Australia in 1929, Ray Allsop introduced the Raycophone sound head to provide sound on film at a fraction of the cost of imported equipment. Following this development, in 1938 at the Regent and Plaza theatres in Sydney, he demonstrated stereo sound from 35 mm film sound tracks.

As the years advanced, projection systems changed. Early projector light sources were open carbon arc lamps which dissipated a lot of heat to obtain the light intensity required. I tried to get some idea of the power involved. I recorded some figures



Projector assembly with sound on film.

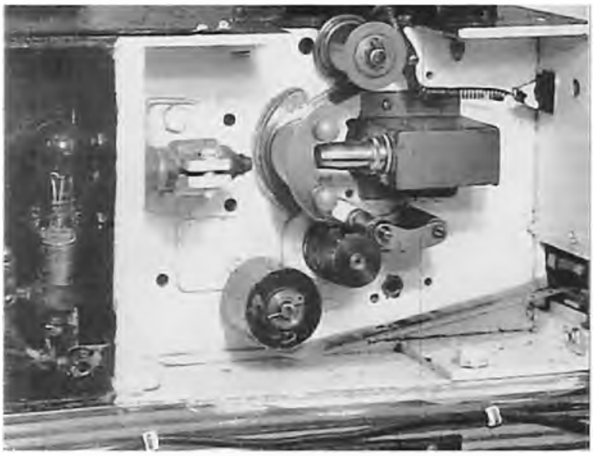


A diagram showing sound on film (from Reference 7).

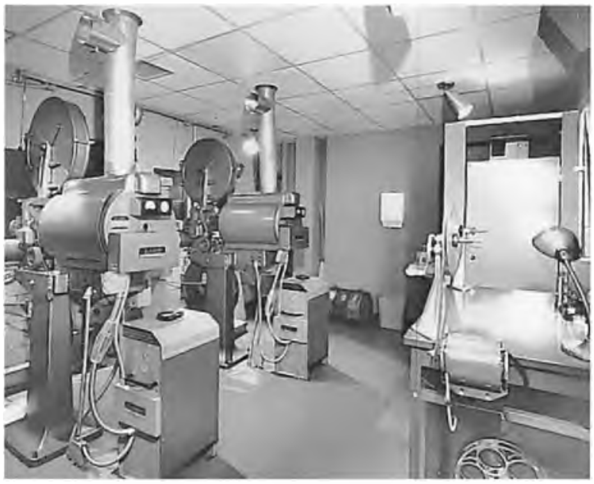
given for the Grauman's Chinese Theatre (Reference 10); 63 to 70 volts DC at 100 to 120 amps (that is around 6,000 to 8,000 watts). During operation, these open arcs had to be continuously monitored and adjusted. Not surprisingly, by around the 1960s, sealed Xenon projection lamps became the normal light source.

Sealed Xenon lamp.

Today, almost all movie projectors in theatres employ these lamps, with power ratings ranging from 900 watts up to 12 kW. A xenon arc lamp is a specialised



The Ray Allsop Raycophone sound head.



Projection room - often called the Bio-Box.

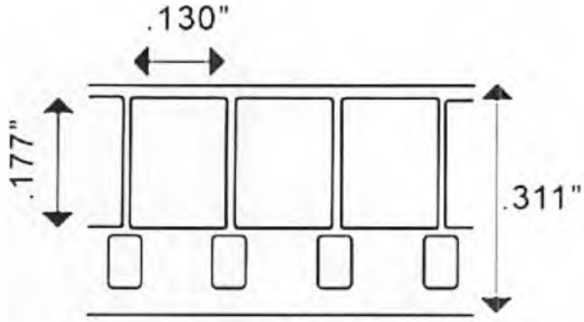
type of gas discharge lamp that produces light by passing electricity through ionized xenon gas at high pressure. They operate continuously without adjustment for lifetimes typically in the region of 500 to 1,000 hours.

Early power amplifiers to drive the auditorium speakers using electron tubes and triodes (such as the 2A3) seemed to be the order of the day. It was always aimed to produce high quality sound in the theatre. Triodes generated predominately even harmonic distortion and this was easily cancelled out by connecting the triodes in push pull configuration. Around the 1960s and 1970s, transistor and solid state circuitry was replacing earlier electron tube circuitry and one might assume that by then most electron tube amplifiers in theatres would have been phased out.

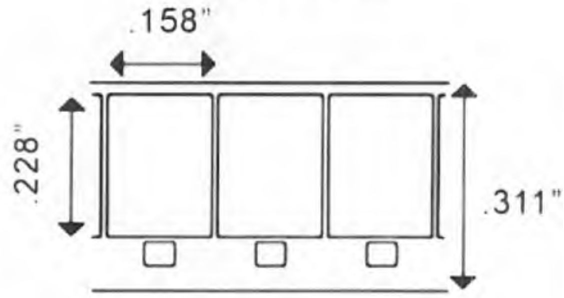
Film formats

Most of the common film formats are described in the text together with a number of diagrams. Some of the diagrams have mixed metric and imperial measurements. My apologies for that but the text on the diagrams was carried through from the original sources. Also for the 9.5 mm film, I was unable to find a diagram with dimensions printed.

The 8 mm film is a film format in which the film strip is eight millimeters wide. It exists in two main versions, the original standard 8 mm film (also known as regular 8 mm) and Super 8. Although both standard 8 mm and Super 8 are 8 mm wide, Super 8 has a larger image area because of its smaller and more widely spaced sprocket perforations.



Standard 8 mm film.



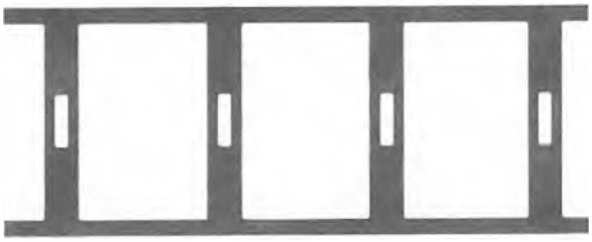
Super 8 mm film.

Standard 8 mm was released by the Eastman Kodak company to the market in 1932 to create a home movie format that was less expensive than 16 mm. The film spools actually contain a 16 mm film with twice as many perforations along each edge as normal 16 mm film. On its first pass through the camera, the film is exposed only along half of its width. When the first pass is complete, the operator opens the camera and the film spool is flipped over. The film is then exposed on a second pass along the other half of its width. After the film is developed, the processor splits it down the middle, resulting in two lengths of 8 mm film, each with a single row of perforations along one edge.

As can be seen from the diagrams, the standard 8 mm film uses a single perforation (or sprocket hole) along one edge centred between each pair of frames, as opposed to the Super 8 mm film which has perforations also along one edge but centred on each frame. The single hole allowed more of the film to be used for the actual image, and in fact the image area is almost the same size as the 16 mm film. Of course, picture resolution displayed on the screen is dependent on the resolution of the image on the film and hence dependent on the size of the film image. Any gain on the image area is a gain on the resolution of the display on the screen.

Super 8 mm film was released in 1965 by Eastman Kodak as an improvement over the older 'Double' or 'Regular' 8 mm home movie format. The film is nominally 8 mm wide, the same as older format 8 mm film, but the dimensions of the rectangular perforations along one edge are smaller, which allows for a greater exposed area. The Super 8 standard also allocates the border opposite the perforations for an oxide stripe upon which sound can be magnetically recorded.

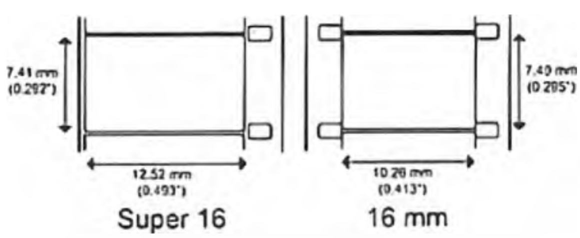
9.5 mm film is an amateur film format introduced by Pathé Frères in 1922 as part of the Pathé Baby amateur film system. It was conceived initially as an inexpensive format to provide copies of commercially made films for home users. As can be seen from the 9.5 mm diagram, the sprocket holes are in the centre of the film between each of the picture frames allowing the frames to take up maximum width of the film dimension and achieve maximum resolution for the film size.



Format of 9.5 mm film (sprocket holes at centre).

9.5 mm movie film became very popular in Europe over the next few decades and is still used by a small number of enthusiasts today. During the years leading up to the Second World War, and for some years after the war, the gauge was used by enthusiasts who wanted to make home movies and to show commercially made films at home.

16 mm film is a popular and economical gauge of film which is used for non-theatrical film making, such as industrial, educational, or low-budget motion pictures. It also existed as a popular amateur or home movie-making format for several decades. Eastman Kodak released the first silent 16 mm film and associated equipment in 1923. RCA-Victor introduced a 16 mm sound format using optical sound track in the years 1932-1935.

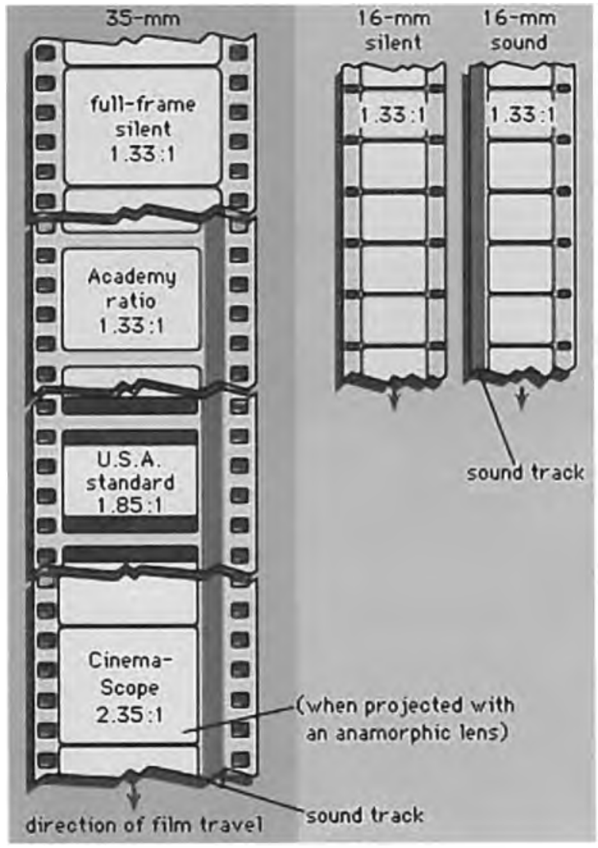


Formats of silent Super 16mm and silent Standard 16 mm film.

The formats for 16 mm film can be a little confusing. The original silent version has sprocket holes down both sides of the film (similar to that for 35 mm film). However, Super 16 mm film has only one side with the sprocket holes, leaving the other side with space to fit an optical (or magnetic) sound track on the other side, or a 20% wider picture frame without room for a sound track.

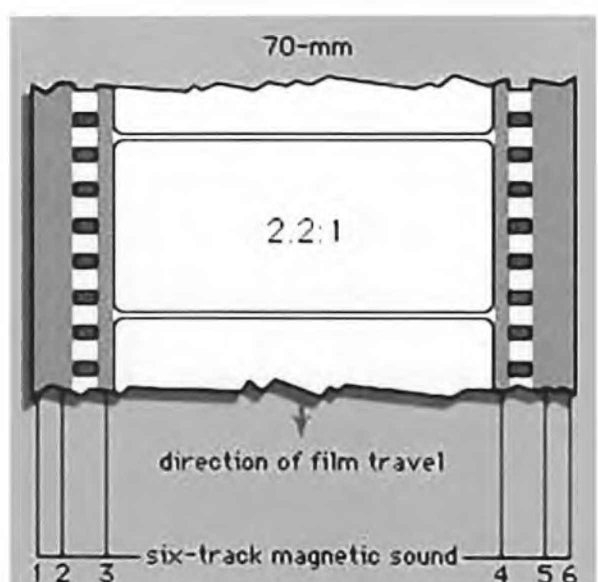
Forms of 35 mm wide film were introduced as early as 1892 but the 35 mm width film and four perforations per frame became accepted as the international standard gauge in 1909. It remained by far the dominant film gauge for image origination and projection in picture theatres until the advent of digital photography and cinematography. This was despite challenges from smaller and larger gauges. Its size allowed for a relatively good trade-off between the cost of the film stock and the quality of the images captured.

The normal sound track on 35 mm film is photographic (as shown on the diagram). However, special presentations of sound on 35 mm film have been recorded magnetically on ferric oxide tracks bonded to the film print, outside of the sprocket holes. 16 mm and Super 8 formats have also been used with a similar magnetic track bonded to the side of the film on which the sprocket holes had not been punched.

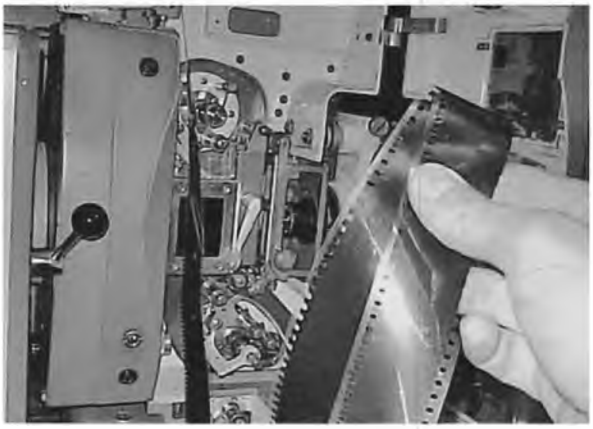


Formats for 35 mm and 16 mm film.

Several digital sound track systems for 35 mm cinema were introduced during the 1990s. Dolby Digital is stored between the perforations on the sound side. Sony Dynamic Digital Sound (SDDS) is recorded on both outer edges of the 35 mm film. Here we get into a complex system useful for a very large cinema auditorium. This system supports up to eight independent channels of sound: five front channels, two surround channels and a single sub-bass channel. DTS (formerly known as Digital Theatre Systems) is a five channel primary (full-range) system, similar to a Dolby Digital setup, plus a special low-frequency effects channel for the subwoofer sound speaker. For



70 mm film with magnetic sound tracks.



35 mm film.

DTS, the sound data is stored on separate compact discs synchronized by a time-code track on the film just to the right of the analogue soundtrack and left of the frame.

Films formatted with a width of 70 mm have existed in the motion picture industry since the 1890s. It is used for still and motion picture photography with higher resolution than the standard 35 mm motion picture film format. As used in cameras, the film is 65 mm (2.6 in) wide. For projection, the original 65 mm film is printed on 70 mm (2.8 in) film. The additional 5 mm is used for four magnetic strips holding six tracks of sound.

The 70 mm film has been used on many of the modern wide screen versions of the movie theatre, making use of the higher resolution of the wider film format.

Moving pictures, frame rate and the projection shutter

Moving pictures, as seen by the human eye, are created by displaying alternate fixed frames of pictures, each one slightly changed from its previous one. If the rate of change is fast enough, the eye interprets the changes as movement. The earliest cameras and projectors needed to be hand-cranked to advance the film through the gate. This led to varying frame rates. Early silent films had frame rates from 14 to 26 frames per second, which was enough to provide a sense of motion, but the motion was often jerky or uneven. Eventually cameras and projectors were motor driven and standard frame rates were established.

A rate of 16 frames per second was set in some early projectors but the general rate of 24 frames per second was eventually established as the standard. However, this is not fast enough to prevent flicker as seen by the eye. So each frame is cut in twice by a shutter rotating at 24 times per second so that 48 fixed frames per second are displayed to the screen. The shutter also blanks out projected light each time the projector moves the film from the displayed frame to its next one.

Diagram of the rotating shutter. The shutter rotates at 24 frames per second. It opens twice per rotation for 90 degrees to allow passage of the light beam. The film moves one frame during every second shutter closure.

When the current frame has been displayed in the light beam twice, and the operation is complete, the mechanism of the projector moves the film to the next frame. That frame remains stationary whilst the frame display is repeated twice. In observing the film running through the projector gate, one might get the impression that it runs through in a steady continuous state. But through the gate, it is a start - stop operation at a repetition rate of 24 per second.

But here is an interesting point of discussion. Our (now superseded) analogue television frame rate was 25 frames per second, locked at half our power line frequency of 50 Hertz (for a number of very good technical reasons). If they displayed a movie film, originally photographed at 24 frames per second, and transmitted frame for frame, did it display on our TV screens 4% quicker?

Fantasia and Fantasound

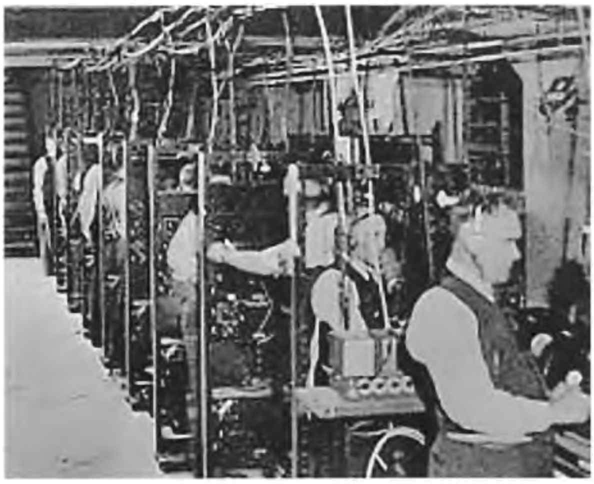
Over the years there has been a multitude of different advanced screen displays, different sound systems and different ways in which the sound is supported by, and synchronised with, the picture information carrier. But even in the mature 1940s there were some quite advanced developments. One such development was the animated film *Fantasia*, produced by Walt Disney and released by Walt Disney Productions in 1940. *Fantasia* was first released in theatrical road show engagements held in thirteen US cities commencing on 13th November 1940. Unfortunately, WWII prevented further circulation throughout Europe.

The SA motion picture theatre group Ozone took over the running of what had been the Lyric Theatre at Murray Bridge in the 1940s. It was around then, in my teenage years, that I met up with a young chap sent to the town by Ozone to run the theatre and its projectors. We talked about motion pictures and the eight track *Fantasia* sound. He was a member of IRE and he loaned me a copy of *Fantasia* as written up in a current issue of the *Proceedings of the IRE Australia*. So my interest started right then.

Fantasound, developed for *Fantasia* in part by Disney engineer William Garity, employed two 35 mm projectors running at the same time and synchronised. One contained the picture film with a mono soundtrack for backup purposes, and the other contained a sound film that contained eight recorded tracks. These were rearranged into four channels, three of which contained the audio for the left, centre, and right stage speakers respectively, whilst the fourth was a control track of amplitude and frequency tones that drove variable-gain amplifiers to control the volume of the three audio tracks.

The system was clearly stereo and probably an early introduction to what we now know as surround sound. In making the movie, eight operators were used to manually control different levels of the eight tracks.

The combination of each pair of tracks is interesting in that they run in push-pull and a push-pull light image is fed via a lens and photo cell to feed the input of a push-pull amplifier. One can guess that they were aiming to cancel out even harmonic distortion generated in the optical sound tracks.



Eight operators are shown controlling the eight sound tracks in the making of Fantasound for the movie *Fantasia*.

The road shows did not continue beyond USA as costs involved did not deliver profit and Fantasound ended in 1941. RKO acquired the film rights in 1941 and replaced Fantasound with mono sound. Disney engineer Terry Porter set up the original sound again in 1990 but the *Fantasia* system was only shown in New York and Los Angeles theatres. A report in the Melbourne *Argus* of 9th September 1941 stated that *Fantasia* was arriving in Australia the following week. Another report listed the start of a road show here on 15th September 1941. However, it must be assumed that this was now a mono sound version.

The standard picture display in early theatres was in an aspect ratio of 4:3 (or 1.33:1). Some later versions of *Fantasia* were reproduced in a widescreen version called Superscope with an aspect ratio of 2.35:1. The 35 mm film frame was still 1.33:1 but, on filming, a special lens (called an anamorphic lens) in the camera compressed the picture in the horizontal axis to the 1.33:1 width. Then, on projection, a special lens (the inversion of the camera lens) in the projector expanded the displayed picture to the original picture aspect seen by the camera. I understand that this is the basis of many wide screen systems, such as CinemaScope, which followed further down the track.

Today's movie theatre complexes

Up to the most recent few decades, individual movie theatre projection rooms were required to be staffed by a certified qualified projection operator, usually accompanied by at least one projection assistant. However, things have now changed with many newer multiple auditoriums and projection rooms in a single large theatre complex. Using the more recent developments of digital systems with computer control technology, digital memory storage, and improved projection safety, these newer theatre systems are staffed with a minimal number of projection operators who control the whole unattended projector operation.

Today we sit in the auditorium, partly surrounded by a massive, almost overpoweringly realistic picture and listen to high quality surround sound. One hundred years ago it was a black and white picture, of limited size and limited resolution, and no synchronised sound. Our motion picture entertainment has come a long way!

If you are interested further in the history of projection and sound reproduction, I suggest you might download the story of the Grauman Chinese Theatre in Hollywood California (Reference 10) in which is documented much of the range of motion picture technologies.

References

1. *Early Silent Powers Projector* - http://www.graumanschinese.org/projection/powers-projector-catalog.jpg
2. *A Brief History of Recording to circa 1950* by Roger Beardsley and Daniel Leech-Wilkinson - http://www.charm.rhul.ac.uk/history/p20_4_1.html
3. *Movie projector* - https://en.wikipedia.org/wiki/Movie_projector
4. *Vitaphone Turntables in Projection Room* - https://en.wikipedia.org/wiki/Vitaphone
5. *The Evolution of Projection Technology* - https://celebrationcinema.wordpress.com/2010/01/29/the-evolution-of-projection-technology/
6. *Murray Bridge's Silver Screens* by Peter Wolfenden, Cinemarecord 2007
7. *In a Talkie Theatre* by John Moyle - reprinted *OTN* Sept 2016, P51-54
8. *Bob Hope and American Variety* - https://www.loc.gov/exhibits/bobhope/mopic.html
9. *Vitaphone Sound on Disc* - http://www.triggertone.com/term/Vitaphone
10. Grauman's Chinese Theatre, Hollywood, - http://www.graumanschinese.org/projection-1.html http://www.graumanschinese.org/projection-2.html http://www.graumanschinese.org/projection-3.html http://www.graumanschinese.org/projection-4.html
11. Capri Theatre Wurlitzer Organ - https://capri.org.au/theatre-organ/

ar

Silent keys

It is with regret that we record the passing of:

Allen	**Crewther**	**VK3SM**
Brian	**Proudlock**	**VK7BP**
Bill	**Hall**	**VK2XT**
Ian	**Simpson**	**VK3XIS**
Joe	**Gelston**	**VK7JG**
Gordon	**Bracewell**	**VK3XX**
Len	**Hearnes**	**VK3BMY**
Bill	**Coates**	**VK5WCC**
Duncan	**Baxter**	**VK3LZ**
Jim	**Griffiths**	**VK2BGG**
Bruce	**Thomas**	**VK2AMT**

ar

Sprague products

Rodney Champness VK3UG
RAOTC member No 1086

The article on Sprague in the March 2018 issue of *OTN* was interesting and the invitation to tell members of their experiences, etc, with Sprague caused me to contact the editor, Bill Roper and ask if he would like an article on the Sprague Interference tracing receivers. He very quickly said yes, please!

As was said in the March *OTN* the Sprague Electric Company of America produced a wide range of electrical components and apparatus. In addition to their general stock-in-trade they also produced a number of specialised receivers known generically as 'Interference Locators'.

These receivers covered nominally the frequency range from around 550 kHz to at least 220 MHz although the Sprague 700 did tune higher into the UHF range. They were used predominantly to trace sources of interference to radio and television reception, and occasionally to two-way radios, although they were never intended to be used for this purpose. To achieve their goal of tracing interference it was necessary that the sets be fully portable and be able to be powered both from an inbuilt battery as well as 110 and 240 volt AC power. When attached to the mains power the inbuilt wet cell battery could be charged. However, portability is a relative term as the Sprague 500 weighs 12.5 kg and measures 33.3 cm high x 32 cm long x 20 cm wide.

The Sprague 400 was the first of these receivers, followed by the 500 in 1959 (the last of the valved units), then the 600, 610, and finally the 700 in 1977. I believe that Eddystone or Belling-Lee (I'm not sure which) made an interference tracing receiver, but I've not seen one.

I have used all models of the Sprague with the exception of the 400. In my opinion, the 500 was the best of these receivers, having minimal spurious responses, whereas the design and mechanical quality deteriorated with each successive model, with the 700 being one of the worst receivers I've ever tried to use. It was full of spurious responses, with most of these generated within the receiver. The tuning stability was so bad that it was necessary to continually retune the set to stay on the tuned station. I think most of these ended up as very expensive land fill! I believe they cost around $2,000 each in 1977.

A front panel view of the Sprague 500 receiver.

A Sprague 500 receiver in working condition.

Despite being well and truly obsolete in the late 1980s, the 500 soldiered on well after the later models were pensioned off. The 600 model was transistorised and used five batteries to power the circuitry. The 610 was intended to overcome its problems, but never did, and the 700, well, what could I say more than I said above. The 500s were modified to some extent to suit the requirements of the government department that used them.

But even the 500 couldn't keep going indefinitely as it was bulky, not very portable and not as sensitive as newer equipment, didn't have facilities to trace interference in the UHF band, and lacked facilities for multimode reception and spectrum analyser operation. The Icom R7000 receiver took over where the obsolete Sprague 500 left off.

A look at the Sprague 500

It is very utilitarian, having a grey crinkle finish aluminium case, with a front, or in this case, a top with test equipment type labelling. It has a carrying handle and a fabric strap to aid its transport in the 'portable' mode.

A look at the controls shows that the receiver tunes from 550 kHz to 220 MHz in six bands. The tuning dial is located at top left while a matching case at top right houses the 'calibrated' relative radio frequency (RF) signal level meter - a real 'guess meter'.

The knob in the centre of the front panel is the on-off control, which is also used to switch on the inbuilt battery charger.

Going along the bottom of the panel from left to right there is the tuning control, followed by the volume, band-change, meter zero and finally the RF attenuator. The RF attenuator is used so that the meter needle stays somewhere near the centre of its scale, even when the RF probe used with the set is quite close to the source of high level interference being traced.

A top of chassis view of the Sprague 500 - note the many trimmer and inductance adjustments.

On the right hand side of the panel is a jack for a set of low impedance headphones (the set has an inbuilt 100 mm speaker as well) and a BNC coaxial cable socket for the signal input. The bulb at the top left of the panel houses a neon indicator that lights when the set is turned on.

The specialist antennas are mostly mounted onto the sockets at top centre of the front panel. The accessories consist of a telescoping rod or dipole antenna (depending on how it is set up), a directional loop antenna for broadcast band, an RF probe, a roof mounting bracket for the antennas, two coaxial cables, a canvas carry case and a set of headphones. Most of these items can be seen in one of the photographs.

A run through the electronics

The circuit is quite conventional with a total of eight valves working very conservatively. It has six bands covering 550 kHz to 220 MHz. The first five bands cover to 54 MHz using a conventional BC/SW front end using a 6BJ6 RF amplifier and a 6BR8 as the oscillator and mixer. The 54 to 220 MHz band is covered by using a modified incrementally tuned VHF TV tuner with a 6AN4 as a grounded grid RF stage and a 6CG8 oscillator and mixer as the second front end. The rest of the receiver is common to both front ends and consists of two 6BJ6 IF amplifiers, a 6AQ6 as detector and AGC and first audio amplifier, followed by a 6AK6 as the audio output stage. AGC is applied to both IF stages and the signal strength meter is wired into the plate and screen circuit of the first IF amplifier.

On the three bands up to 14 MHz the IF frequency is 455 kHz, but on the three bands above 14 MHz the IF frequency is 10.7 MHz. With the broader IF on the

The Sprague 500 with case hinged to show the works.

The Sprague 500 accessories.

higher frequencies it is much easier to tune VHF frequencies as there is no bandspread in the tuning system and the tuning does drift on higher frequencies.

Power supply

The valves, with the exception of the oscillator/mixers, are all low heater current types, and also draw low HT current. The HT is only 120 volts on the plates of the valves. This helps to reduce the total current drain of the set when using the internal lead acid battery. The battery is a special 6 volt 20 amp hour battery which is now unprocurable.

To further reduce the current drain, the two front ends have heaters switched on only when that particular tuner is being used. Hence, if you switch from band A to band F you have to wait for about 20 seconds for the particular tuner to become operational.

The receiver is powered from the six volt battery at all times. There is no regulation in the charging circuit so it is necessary to observe the hydrometer balls in the battery to ascertain the charge state of the battery. The holes in the back of the cabinet are for this section of each battery cell to be visible. The original battery was an early attempt to provide a leak proof battery as it had several inches of rubber tubing going up from the filler on the battery. This meant that accidentally tipping the set over did not cause acid to spill. Remember, these sets were produced before fully sealed batteries were commonly available. With the special batteries now unobtainable, a six volt sealed lead acid battery of around 10 amp hour capacity (AHC) will fit into the space available.

As the set operates off six volts, it is necessary to have a DC/DC power supply to provide the required 120 volts of HT. This is achieved using a simple two-transistor inverter.

Summary

The Sprague 500 isn't the prettiest receiver around. It has a very wide tuning range so all sorts of services could be listened to in its heyday. It is basically an AM receiver, but with careful tuning it will resolve FM transmissions using slope detection. This is not the best FM detection method but is quite functional.

The sets proved to be very reliable, had reasonably low current drain for their time, were portable (!), reasonably sensitive, and were quite reasonably accessible considering their complexity.

It was an excellent set for its time and intended purpose (interference tracing), and made quite a reasonable entertainment radio as well. I doubt there are even a dozen of these sets in the hands of restorers in Australia, as it is a relatively rare receiver. I am pleased that I have one in my collection.

This is an excellent example of Sprague products of the late 1950s.

ar

Lithium batteries: a power source for QRP portable operations

Clive Wallis VK6CSW
RAOTC member No 1289

In recent times, QRP portable operations such as Summits on the Air (SOTA), activating parks, or just having fun operating portable, have become increasingly popular. One compact, lightweight source of power is the lithium polymer battery intended to operate electric model aircraft, cars or boats. These relatively inexpensive batteries pack a considerable punch and have undergone significant development over the past decade or so. They do need to be treated with some care, however, as misuse can have serious consequences.

This article outlines the history of the LiPo battery, how it works, and suggests ways to get the best out of these excellent power sources. I make no claim to being expert on the subject but I have used them for a number of years to power electric model aircraft and have built several successful chargers specifically for these batteries.

Let's start with a brief look at the basics. Lithium is a soft, silvery-white alkali metal which at room temperature is the lightest solid metal and the lightest solid element. Its melting point is 180° C. Like all alkali metals (such as sodium and potassium) lithium is highly reactive and flammable, and is potentially explosive when exposed to moist air and especially to water because the reaction creates hydrogen gas.

From a voltaic cell perspective, lithium is attractive because it gives up its electrons easily and can be used to create a rechargeable cell with a voltage and power density (watts per unit weight) significantly higher than that of lead-acid, nickel-cadmium or nickel metal hydride cells. But lithium's instability initially made it difficult to produce a safe cell commercially.

Once this problem was overcome, lithium ion cells - strictly speaking, a battery consists of two or more cells - have been in widespread use since about 1991 and are now produced in huge numbers, billions per year. They are used to power all sorts of portable devices such as laptops, cell-phones, music players, as well as electric powered model aircraft, drones, cars and boats. They are even now being used to power full-size electric road vehicles and even light aeroplanes and especially auxiliary powered sailplanes.

The basic chemistry of the cell was discovered by the American chemist Gilbert Lewis (1875-1946) over a century ago in 1912 but it is only in more recent times that its less desirable characteristics, such as a tendency to thermal runaway and self-ignition, have been tamed. Even now we hear of instances of fires in lithium battery powered devices but, in comparison to the vast quantities in daily use, these events are rare and need to be kept in perspective rather than sensationalised.

In the quest for a better battery which could offer commercial advantage, in 1970 Exxon Corporation funded British chemist M S Whittingham to revisit Lewis' work but the cell could not be made practical due to the choice of lithium metal and titanium sulphide as the electrodes, the former being unstable and the latter making the battery extremely expensive. Nevertheless, the possibility of developing a battery based on lithium with a significantly higher power density than the other technologies then available spurred further interest and research.

A significant breakthrough occurred in 1979 when Ned A Godshall, working at Stanford University in the USA, and shortly thereafter John Goodenough and Koichi Mizushima working at Cambridge University in England, demonstrated a rechargeable lithium cell having a fully charged potential of about 4 V using lithium cobalt oxide ($LiCoO_2$) as the positive electrode (anode) and lithium metal as the negative electrode (cathode). This innovation provided the positive electrode material that made lithium batteries commercially possible but safety remained an issue.

Because of the inherent instability of lithium metal, especially during charging, research shifted to a non-metallic lithium battery using lithium ions. Although slightly

The author's Turnigy Accucell 6 multifunction charger charging a 2.2 A 20C nanocell battery using his homebrew DC supply. Note the main charging leads and the smaller balance leads

lower in energy density than lithium metal, lithium-ion is safe, provided certain precautions are observed when charging, discharging, storing and transporting.

Even today, although lithium-ion battery powered devices can be carried on passenger aircraft, strict guidelines as to maximum battery capacity housed in the device must be met by the manufacturer. The bulk carriage of lithium batteries on passenger aircraft is prohibited; in bulk they must be carried in cargo-only aircraft and then only then when strict criteria relating to packing method and state-of-charge are observed.

A primary cell is one in which the reaction consumes the cell's constituents and is non-reversible; once the active materials are consumed the cell is dead. A secondary cell is one in which the reaction which produced the electricity is reversible, thus the cell can be recharged.

While primary (non-rechargeable) lithium cells are commonplace, often in the form of button batteries, when we think of lithium batteries we usually have the rechargeable (secondary cell) type in mind, specifically the lithium ion polymer type, commonly abbreviated Li-Po, LiPo, LIP or Lipoly. This uses a semi-solid polymer gel electrolyte and is the type found in most portable applications where weight is a critical factor. Lithium ion batteries with a liquid electrolyte most certainly exist but are seen more in large industrial use. Here we are concerned mainly with the gel Li-Po cell.

Unlike NiCad or NiMh cells which can only be connected in series, any number of ***identical*** Li-Po cells can be connected in series, parallel, or series-parallel to form a battery of any desired voltage and current rating. Also, they do not suffer from 'memory effect', a real problem with Nicad and NiMh cells.

All electric (voltaic) cells work by chemical reaction and require three basic ingredients: an anode, a cathode and an electrolyte. The anode is the electrode where oxidation (loss of electrons) occurs; the cathode is the electrode where reduction (gain of electrons) occurs; and the electrolyte serves to promote the reaction of the chemicals within the cell. The Li-Po battery has a fourth and vital component, the separator, a micro-porous film which isolates the anode and cathode electrically while allowing free passage of lithium ions between the two. The integrity of this membrane is vital.

In the Li-ion polymer cell used by modellers, which has a nominal voltage of 3.7 V, the positive electrode is most commonly made of lithium cobalt oxide ($LiCoO_2$), in the form of a crystal lattice, with the electrical contact to the battery terminal made of aluminium, though other lithium oxides such as lithium manganese oxide ($LiMn_2O_4$), lithium iron phosphate ($LiFePO_4$) or lithium nickel manganese cobalt oxide ($LiNiMnCoO_2$) are sometimes used for specific applications. The negative electrode is usually made of a graphite or graphene lattice, a form of elemental carbon, with the electrical contact made of copper.

WARNING. Different lithium battery chemistries have different maximum and minimum voltages. NEVER use anything but the proper charger applicable to the particular chemistry. To do otherwise is dangerous and courts disaster. Here we deal only with lithium polymer technology.

Li-ion cells are based on intercalation (interleaving) of lithium ions in the compounds composing the anode and cathode. The compounds are materials with a layered or lattice crystalline structure that allows lithium ions to migrate from, or reside between, the layers. When a load is connected to a charged Li-Po cell, ions move from the negative carbon based electrode through the electrolyte via the porous separator to the positive electrode, in our case lithium cobalt oxide, $LiCoO_2$, causing electrons to move in the opposite direction around the external circuit to power the load. Once the ions in the negative electrode are used up, current stops flowing. Charging the battery forces the ions to move back across the electrolyte and embed themselves in the negative electrode's structure, ready for the next discharge cycle.

While the chemistry of each battery type depends upon the particular composition of the anode and cathode, in each case the principle of the lithium ion battery remains the same. Figure 1 gives the general idea.

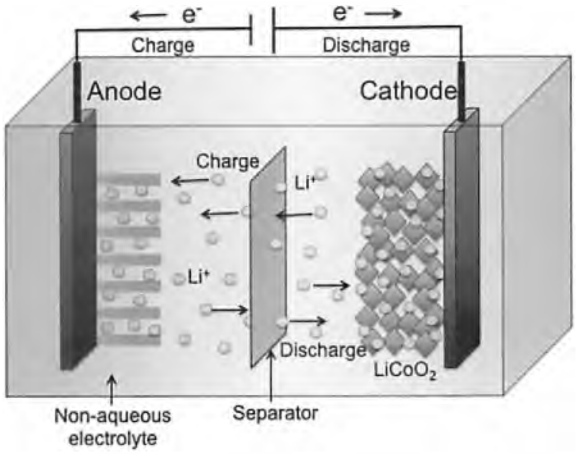


Figure 1 - Li-Po principle.

As with all things, while these compounds work satisfactorily, they are not perfect. Every time the ions migrate, some will react with the electrode to become an intrinsic part of the material and thus are lost to the electrochemical reaction, resulting in a gradual loss of the battery's capacity with each charge/discharge cycle. Additionally, each charging cycle causes a tiny but cumulative increase in the volume of the electrodes which stresses the crystalline structure causing microscopic damage which gradually diminishes the electrode's ability to accommodate free ions. Rapid or overcharging can also cause gas to form, the combined effects making the battery swell as well as limiting the

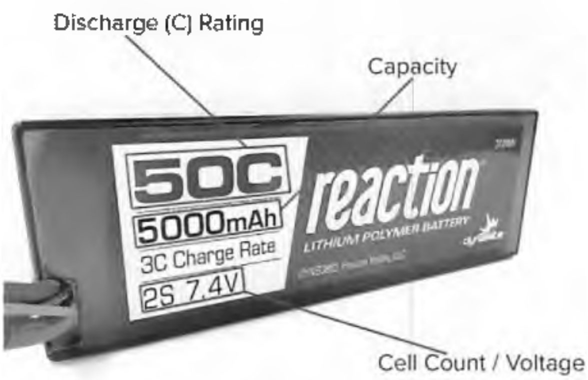
Swollen Li-Po battery.

number of cycles obtainable. A battery is usually considered spent once its capacity is 80% of its nominal value.

Addressing these weaknesses has been the focus of much Li-ion battery research, with a primary goal of packing more lithium ions into the electrodes to increase the energy available for a given volume. This improvement also makes it easier for the ions to move in and out of the electrodes, and enhances ion mobility through the electrolyte.

In the case of Li-Po batteries used in electric models, the refinements have mainly been to the carbon negative electrode. Some years ago the use of nano technology improved the available surface area, while more recently graphene, a form of carbon in a single layer of carbon atoms arranged in a hexagonal lattice, has brought further improvements to both the amp-hour capacity, discharge and recharge rates.

Batteries used by modellers - and hopefully now by portable radio enthusiasts - have three important parameters marked on them: voltage; amp- (or milliamp-) hour capacity; and C rate. You may also see batteries referred to in terms of S (series) and P (parallel), denoting the way the cells are connected. Thus 2S2P means two cells in series paralleled by a further two cells in series. 4S3P means 12 cells with three paralleled sets of four cells in series. All cells in the battery must be identical. Where no cells are paralleled the P may be discarded and the S marking stands alone.



Battery markings

Now to voltage. Since the nominal voltage of a single Li-Po cell is 3.7 V, it follows that batteries will be marked in multiples of this figure, ie 3.7, 7.4, 11.1, 14.8 V, etc. The usual maximum charge voltage per cell is 4.2 V and the minimum safe working discharge voltage is 3.0 to 3.3 V. If any cell is discharged below about 2.2 V it may no longer be rechargeable. Thus a 4S battery would have a working voltage from 16.8 V fully charged to about 12.6 V discharged, suitable for most transceivers requiring a nominal 13.8 V input.

Amp-hour or milliamp-hour capacity is always quoted at the 1C discharge rate.

C rate is the current draw which will discharge the battery in one hour. The C-rating is a multiplier which, when applied to the C rate, gives the (theoretical) maximum discharge current the battery should be able to supply.

So, 20C means 20 times the one hour discharge current. Thus a 3000 mAh capacity battery has a C rate of 3000 mA (or 3A). If it has a C-rating of 25, it should be able to deliver 25 x 3 = 75 A. If it has a C-rating of 40 it can, in theory, deliver 40 x 3 = 120 A maximum. Additionally, most modern batteries subdivide C-rating into 'continuous' and 'burst' (10 seconds maximum). Thus a 3000 mAh, 40C (80C burst) battery can provide 120 A for 1.5 minutes or a staggering 240 A for intermittent periods not exceeding 10 seconds! Believe it or not, these figures are quite achievable, at least when the battery is fresh and fully charged.

The C-rating and the battery's internal resistance are obviously interrelated. The lower the internal resistance, the higher will be the current rating and the lesser the internal heat generated during discharge. Internal resistance increases as the battery undergoes more charge/discharge cycles and thus its ability to supply high current diminishes. If the current demanded becomes excessive, internal heating may lead to rapid deterioration of the battery and also the risk of thermal runaway and fire.

The charging rate, internal temperature and depth of discharge all affect a Li-Po battery's life. The 'ideal' charging rate is usually 0.5C to 1C (1.5 A to 3 A for the above example) but can be much higher depending on the manufacturer's guide lines. Correct charging is essential and should always be done using a dedicated Li-Po charger. Charging at too high a rate can lead to a rise in the battery's internal temperature. Temperatures above 30° C are deleterious to Li-Po chemistry and should be avoided whether caused by incorrect charging, discharging too rapidly or improper storage. Leaving your Li-Po powered laptop or cell phone in the car on a hot day is not a good idea!

If during charging or discharging the internal temperature rises beyond about 60° C, thermal runaway and fire become real possibilities. An accidental short circuit or a malfunctioning charger can create this situation and for this reason high-power Li-Po batteries should always be charged under constant supervision and preferably inside a fire-proof bag. There are several well-documented instances of modellers losing their cars and even their homes to self-igniting Li-Po batteries, to say nothing of models, and we've all read about laptops and cell phones going up in flames. The most likely causes are either a short-circuit or a malfunctioning charger.

Most Li-Po mishaps occur during charging and the importance of correct charging technique cannot be over-stressed. Never use anything but an approved charger and it's wise to put the charger and battery on a fire-proof surface. Batteries for models have two sockets on the end of short flying leads; a heavy-duty 2-pin polarised socket for powering the load and for recharging, and a light-duty JST-XH multi-pin socket for balancing the individual cells wired in series (or paralleled cell groups) within the battery. The ideal charging graph, Figure 2, is worth studying.

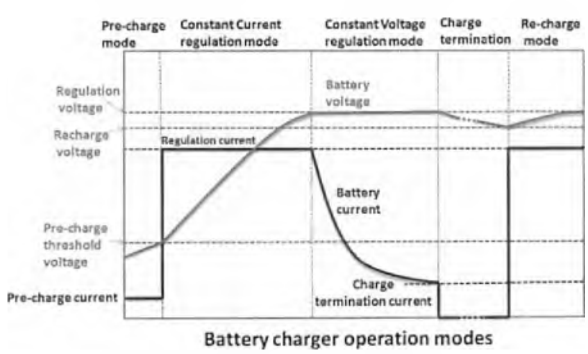
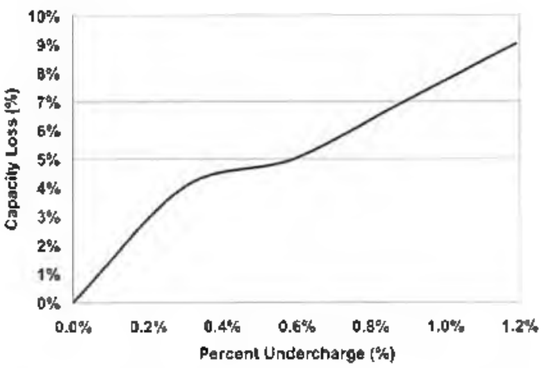


Figure 2 - Li-Po charger stages.

Should the battery be deeply discharged to below about 3 V per cell, a small 'pre-conditioning' charge at about one-tenth of the normal charging current is applied until the cell voltage rises to 3 V. If this is not done, the application of the full charge current can cause destructive local hotspots within the cell. Bear in mind that here we are discussing batteries for models. Cell phones, laptops and other devices have electronic cut-outs which disconnect the battery well before deep discharge occurs. Similarly, their inbuilt charging circuitry prevents over-charging.

Once the voltage is above 3 V per cell, the full charging current, typically 0.5C, is applied until the voltage per cell rises to 4.2 V when the charger switches to the 'constant voltage' phase, gradually reducing the charging current while maintaining the voltage until maximum capacity is reached at 4.2 V per cell. During this phase the charger will balance the end-point voltage of each cell (or paralleled cell group) to within a few millivolts via the JST-XH socket. Once the cells are 'balanced' the charger will shut off automatically.

Undercharging of these types of battery is not recommended. It's not dangerous and may well extend battery life but undercharging by as little as 1% can significantly reduce capacity, perhaps by as much as 8%. See Figure 3.



Under charging by just a small amount reduces battery capacity significantly.

Storage of Li-Po batteries needs some consideration. Avoid storing them fully charged and in high ambient temperatures. Self-discharge rates are normally very low but increase quite rapidly above about 30° C. For longest life, these batteries should be stored between 20-25° C at 3.8 V per cell. A fully charged battery is under internal stress and unless it is to be used within the next few days should be discharged to 3.8 V per cell.

Most chargers have a Li-Po Storage function that will either charge the batteries up to that voltage, or discharge them down to that voltage, whichever is necessary. However, if the storeroom temperature is likely to exceed 25° C then placing them in a refrigerator may be preferable, but not in the freezer; temperatures below minus 20° C may ruin them. Any battery taken from cold storage must be allowed to acclimatise to room temperature for 24 hours before charging or discharging.

To summarise:

Li-Po advantages:

- High energy density;
- Can be made in almost any size, shape and capacity;
- Rechargeable;
- High to very high discharge rate;
- Low internal impedance;
- No memory effect; and
- Low self-discharge rate below 30° C

Li-Po disadvantages:

- Deteriorates gradually from day of manufacture;
- Use of proper balance-charger is essential;
- Limited number of charge/discharge cycles
- Sensitive to high temperatures;
- If fully discharged, may not be rechargeable;
- Moderately expensive, especially for high capacity batteries; and
- If punctured or misused, may self-ignite.

What of the future? Inasmuch as the rechargeable lithium battery has largely displaced NiCad and NiMh technology, how long before an even better technology is found? If history is any guide, we may not have to wait too long for an even more potent source of portable stored power to come along!

I hope that the foregoing will encourage amateurs keen on portable, low-power operations to consider model Li-Po batteries as a lightweight power source but one which needs proper care and handling to achieve the best results.

If interested, a good starting point to see what is available for your needs is Hobby King, a worldwide dealer specialising mainly in Turnigy brand batteries and chargers, a good middle-of-the-road brand which has kept me happy for years. Simply Google 'hobbyking' then select 'Batteries and Chargers'.

Principal references

Battery World website; Battery University website; Hobby King website; Wikipedia - many different references; personal experience. ar

Remember this? A 1939 *QST* advertisement for the classic HQ-120-X superhet receiver.

Solar farms photovoltaic modules on a large scale

Lloyd Butler VK5BR
RAOTC member No 1495

This article should be of interest to all readers concerned about the future of electricity supply, particularly those using solar panels to boost their supply. AGL Energy has used cadmium telluride (CdTe) thin film photovoltaic (PV) modules to generate electricity from the sun at solar farms at Nyngan and Broken Hill, which are amongst the largest PV plants operating within Australia.

Introduction

Energy company AGL has been in the news lately concerning its announcement that it intends to close Liddell coal power station (2,000 MW) in March 2022. However, there is possibly less known about some of its new energy projects. Reference 1 gave a lead into some recently finished AGL solar power projects using photovoltaic modules.

According to the AGL website, the PV modules used by AGL to convert solar energy to electricity have one of the smallest carbon footprints of any current PV technology. Over 5,000 MW of these solar PV modules have been installed worldwide, including at many of the world's largest solar PV plants, with no air emissions, no waste production and no water use.

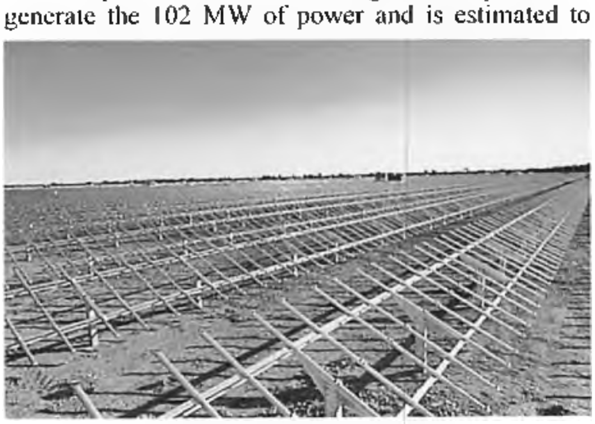
The projects

In conjunction with the Australian Renewable Energy Agency (ARENA) and the NSW Government, AGL delivered two large-scale solar photovoltaic power plants with a total capacity of 155 MW (AC) at Nyngan (102 MW) and Broken Hill (53 MW) in regional New South Wales. ARENA provided $166.7 million in funding and the NSW Government provided $64.9 million.

The two solar plants were constructed in association with each other between July 2014 and December 2015. The Broken Hill plant was officially opened in January 2016 and became fully operational in December 2016. It consists of enough solar panels to generate the 53 MW and supply an estimated 126,000 MWh of electricity each year, which should be sufficient for the needs of approximately 20,000 average households.

The Nyngan solar plant became fully operational in July 2016. The plant is located on an agricultural property approximately 10 kilometres west of the Nyngan township. It occupies about 250 hectares of land to the north of the Barrier Highway.

The plant consists of enough solar panels to generate the 102 MW of power and is estimated to produce 234,000 MWh a year, enough for 39,000 households. It consists of approximately 1,350,000 solar PV modules installed on frames which are supported by around 150,000 steel posts. The modules are installed at a 25 degree angle, facing north. They are connected to inverters which transform the DC produced by the modules into AC that can be fed into the electricity grid.



Nyngan solar panel frames.

Nyngan solar panel field.

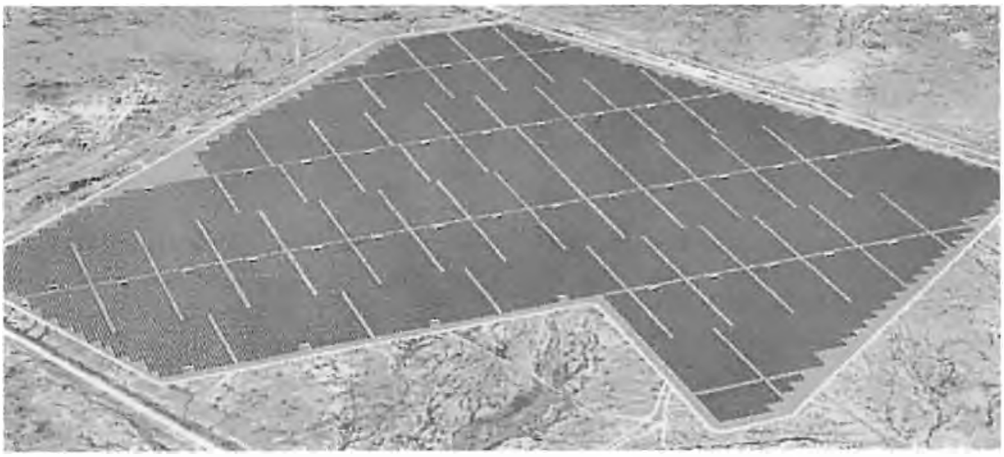
A new substation was built at the site, and a new 132 kV transmission line connects the substation to the existing Nyngan-Cobar transmission line, which runs 3 km south of the site.

The Broken Hill Solar Plant consists of a 53 MW solar PV power station located five kilometres southwest of Broken Hill. The solar plant occupies approximately 140 hectares of land bounded by the Barrier Highway to the north and the Peterborough-Broken Hill rail line to the south.

Over 650,000 solar PV modules are installed at the site. The modules are fitted at a fixed (non-tracking) tilt, at a 25 degree angle facing north. The modules are wired together in standard arrays which are connected to inverters to transform the DC produced by the modules into AC that can be fed into the grid network.

The total cost of the projects was $440 million. The project was developed and managed by AGL Energy in partnership with First Solar, and the Bogan Shire and Broken Hill councils and communities.

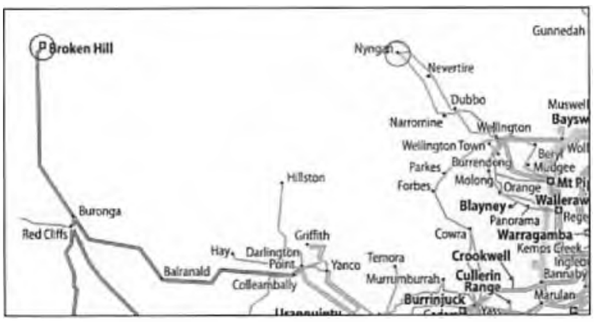
Following completion of the two projects in November 2016, ownership was transferred from AGL to the Powering Australian Renewables Fund (PARF), which is an infrastructure fund closely associated with, but independent of, AGL. The sale was for $257 million, with virtually nil profit. (This includes a long-term off-take agreement with both plants for AGL.) PARF was created with $200 million invested by AGL and up to $800 million from both the Future Fund and a Queensland Investment Corporation infrastructure fund.



An aerial view of the Broken Hill Solar Field with over 650,000 solar photovoltaic modules installed.

The project will reduce greenhouse gas emissions by over 195,720 tonnes of CO_2 equivalent per annum, assuming a rate of 0.84 tonnes per MWh of electricity. This is roughly equivalent to removing 53,000 cars from the road. Particulate and heavy metal emissions will also be reduced.

Both the Broken Hill and Nyngan plant operate into the NSW section of the National Grid; Broken Hill into the 220 kV transmission line and Nyngan into the 132 kV transmission line.



A map showing the relative locations of Broken Hill and Nyngan and the Grid 220 kV High Voltage Connector transmission line to Broken Hill and the 132 kV High Voltage Connector transmission line to Nyngan.

Energy from the photovoltaic modules

For open sunlight, we can consider the energy delivered across a flat plate to be about 100 mW/square cm at these latitudes. Early PV modules had efficiencies as low as 10%, so that energy developed was in the region of 10 mW/square cm. However in the era around 2014-2016, American company First Solar was able to achieve efficiencies approaching 22% using cadmium telluride (CdTe) thin film techniques. So now we have solar energy developed at more than 20 mW/square cm or 200 W/square metre.

Summary

Large scale solar farms have been built by AGL Energy at Nyngan (102 MW) and Broken Hill (53 MW) using high efficiency cadmium telluride (CdTe) thin film photovoltaic (PV) modules. Nyngan farm occupies 250 hectares and Broken Hill farm 140 hectares. Built on open country areas of New South Wales, they should trap plenty of sun-sourced energy to feed the National Power Grid.

Anticipated powers supplied per year are Nyngan 230,000 MWh and Broken Hill 126,000 MWh to 39,000 residents and 20,000 residents respectively. Hopefully it will help to provide a cheaper source of power. It is a pity that these types of projects went ahead without simultaneous provision of large scale energy storage, at least somewhere on the grid, to regulate supply to the varying loads and store the energy when the sources exceed the load demand.

References

1. Solar Plants to power 50,000 households - *Advertiser* 6th October 2017
2. Thin-film solar cell - https://en.wikipedia.org/wiki/Thin-film_solar_cell
3. First Solar - https://en.wikipedia.org/wiki/First_Solar
4. AGL Solar Plants - https://www.agl.com.au/about-agl/how-we-source-energy/renewable-energy/broken-hill-solar-plant
5. Nyngen Solar Farm - https://en.wikipedia.org/wiki/Nyngan_Solar_Plant
6. Nyngan Solar Plant - https://www.agl.com.au/about-agl/how-we-source-energy/renewable-energy/nyngan-solar-plant
7. Broken Hill Solar Plant - https://www.agl.com.au/about-agl/how-we-source-energy/renewable-energy/broken-hill-solar-plant

ar

Restoring a hand key - before and after

Herman Willemsen ex-VK2IXV
RAOTC member No 1384

In mid-2017 I purchased a derelict hand key on eBay. To say that the key was a shadow of its former self is a gross understatement. It was a complete ruin! I had bought it for a song and was soon reminded of the fact that you get what you pay for.

This brass and wood hand key was missing its knob, one of the round brass contact mounts and part of its spring pull bar. In addition, the key's brass lever was cracked in the middle and a parallel bearing (pivot) pin made the key's lever sway from side to side during its up-and-down action.

The derelict Morse hand key before restoration.

I contacted the famous British Master Morse code key maker Ron Ayling G3YUH, with whom I have done business before. You can admire his work on his website at *http://g3yuh.com/*

I airmailed Ron the existing contact block and the incomplete spring puller bar. He was happy to reproduce these parts. Then I approached three of my talented local contacts.

First cab off the rank was my woodworker friend John Daniel, who made me a beautiful knob from rose wood and gave the base a polish. Stephen Ray, a retired jeweller, hard-soldered the crack in the arm of the straight key.

The underneath of the hand key before restoration.

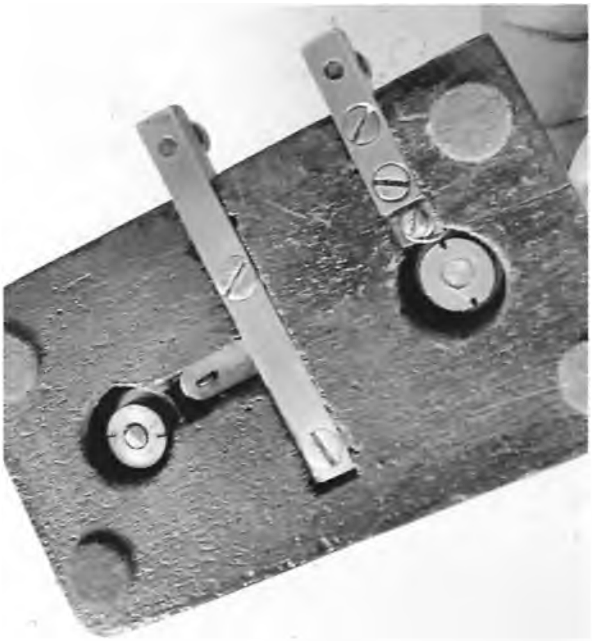
Ron Ayling G3YUH with his Collins equipment.

In no time at all, Ron Ayling made a remarkably precise reproduction of the missing bits. I suspended the new round contact block for some hours above ammonia fumes to give it a more aged green-brown patina. A new tapered bearing pin was made by my friend and RAOTC member Larry Hazzard VK2LPH, who also gave the hand key its final tune.

The fully restored Morse hand key.

I asked Ron Ayling how he moved into making Morse code keys. This is Ron's story:

"Ron lives in Margate, East Kent and started his career as a TV engineer



The underneath of the Morse hand key after full restoration.

but moved into Telecommunications with Philips, Simoco and the National Shared Frontline Emergency Services[1]. In 1998 he retired (in his words) just north of 50 years old.

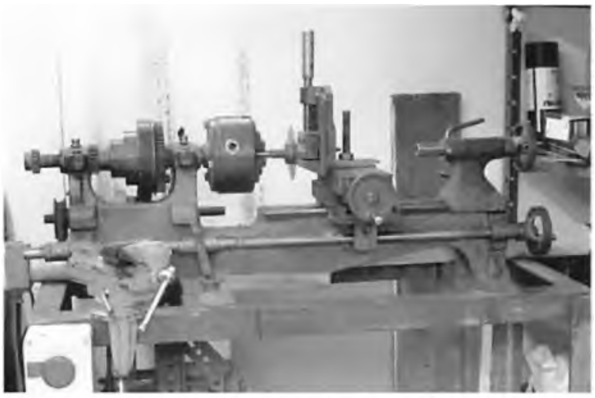
"He has an Axminster Micro Mill, a Clarke CL500M lathe and an old - 100 years plus - lathe which he still uses for shaping and slotting. The latter he obtained in 2006 through eBay for £80 (approximately AU$130). In addition he has a metal bandsaw for cutting.

"He built his first homebrew Morse key in 2005 without any special tools. Then, with the old lathe in the back of his garage, he made 160 keys.

"In 2014, Morse key No 161 was the first key he made with his modern lathes in his new workshop at the back of his garden. Officially he made 257 homebrew keys but there were more as, after No 257, he made a few more 'replicas', some of which were conversions of more recent bugs and refurbishments of partial keys.

"His workshop is solar powered (when the sun shines in England!) so his keys are green or at least

Key parts reproduced by Ron G3YUH.



The century old lathe still used by Ron Ayling G3YUH for shaping and slotting.

partially green. He does not use a CNC router[2] or any other computerised tooling to assist him."

Finally the hand key was restored close to its former glory thanks to all those involved. This Morse key resurrection exercise proved to be relatively time consuming and costly, but who cares, as the end result was well worth the effort.

Footnotes

1. Telecommunications for the front line emergency services shared with the Kent Fire Brigade, Police, Ambulance, Customs and Excise, and others.
2. A CNC router (Computer Numerical Control router) is a computer controlled cutting machine related to the hand held router used for cutting various hard materials, such as wood, composites, aluminium, steel, plastics, and foams.

Acknowledgements

Ron Ayling G3YUH, Phil Boyle, John Daniel, Larry Hazzard VK2LPH and Stephen Ray.

ar

Radio Amateurs Old Timers Club Australia Inc

In accordance with the Rules of Association, notice is hereby given of the

Annual General Meeting 2018

of the *Radio Amateurs Old Timers Club Australia Inc*

to be held at

12.00 noon on Thursday, 27th September 2018

at the

Bentleigh Club, Yawla Street, Bentleigh, Victoria.

Business: Confirm minutes, adopt accounts, elect committee members.

(Note: All the existing committee members are willing to continue in office and offer themselves for re-election.)

The AGM will be followed by the Melbourne September Luncheon at 12.30 pm.

The guest speaker at the luncheon will be Malcolm Adams, a physicist, engineer and lecturer specialising in electronic design of instrumentation and control systems. His talk, 'My life as an electronic engineer', will be very interesting.

The luncheon comprises a three course meal, plus tea and coffee at a cost of $36.00 per head (fruit juice, soft and alcoholic drinks at members' prices).

Members are welcome to bring a friend, but we must have firm bookings to PO Box 107, Mentone 3194 no later than Monday, 24th September 2018.

Nomination for RAOTCA Inc Committee

In accordance with Rule 51 of the Rules of the Association.

I, ______________________________ *(name and callsign)*

hereby nominate ______________________________ to the committee of the **RAOTCA Inc.**

Signed by: ______________________________ *(proposer)*

I agree to accept nomination, signed by: ______________________________ *(nominee).*

All nominations must be returned to:

The Secretary
PO Box 107
Mentone VIC 3194

to reach him by 13th September 2018.