Welcome to

RADIO WORKS '95

'SEE HOW RADIO *WORKS*'

Souvenir Guidebook

presented by the:

GGREC.

Gippsland Gate Radio & Electronics Club

Novemeber 1995

RADIO WORKS '95

Welcome to our first public display of radio technology. Radio has been a part of our culture for most of this century. In that time the equipment has changed but the concepts that make a radio work still remain the same.

Today, the members of our Club have brought together a range of equipment and demonstrations to reflect a segment of history and to reveal a little bit about what makes radio *work*.

EARLY BROADCAST RECEIVERS

With the immense distances in Australia. our populace was quick to embrace the power of broadcast radio. For many. the concept of instantaneous news and entertainment across the land was the first *useful* application of electrical energy. There was much debate about how this medium should be organised and controlled. Several systems were adopted and abandoned. One method had all receivers pre tunned to specific stations and sealed in the factory, so that you could only hear the stations permitted by your license.

In these early days many amateur radio operators would regularly broadcast music and other entertainment to would be listeners. Some of these operators formally expanded their operation and went on to be granted formal radio station licenses with callsigns still familiar today. The station 3AK was one example of this.

Assembled here is an intriguing range of these broadcast receivers, many of which are still fully functional. The era that produced these devices was characterised by an enormous range of enclosures and dial controls, demonstrating the vivid and resourceful imagination's of their builders. A far cry from today's large scale manufacturing processes where you can have whatever radio you want provided it's *black*. Note how each dial was calibrated by its station identities in each state, rather than a simple frequency dial that we now accept as standard.

The vacuum tube was the core of the radio. Apply the appropriate voltages and it will change a small signal into a big one. This was the *real* breakthrough.

A receiver must have two things, ***sensitivity*** and ***selectivity***. The sensitivity is necessary to pick up a weak station. The Selectivity allows you to select just one station instead picking up several at once. If you have an antenna, and an amplifier and a loudspeaker, the only item needed to make a working radio receiver is the **Tuner**. This is the important bit. Early receivers known as TRF receivers, stretched the limits of technology and mechanical engineering in trying to deal with the **sensitivity/selectivity** trade off. Nonetheless, the performance of these radios still compete well with the products available today.

When you examine these receivers on display, try to imagine a world where a person would gladly spend a months wages for a receiver that may only yield them a single station.

The TRF receiver was quickly rendered obsolete by the ***Superheterodyne*** receiver. This method combined the qualities of the selectivity and sensitivity without the need for expensive coils and condensers that needed to be mechanically synchronised.

In the Superheterodyne receiver a weak radio signal is generated *inside* the unit which is mixed with the incoming signal from the antenna. The *difference* between these two signals is amplified and directed to the loudspeaker. To tune to a different station you need only to shift the frequency of the internally generated signal.

See if you can pick which of the receivers on display use this technique.

AN EARLY AMATEUR RADIO STATION

This display shows what an aspiring amateur radio operator may have had in the nineteen fifties. Note the early Call Book. This was like a telephone directory of all Australian operators. The morse key shown is one of the popular *side paddle* keys. It was a finely balanced pendulum arrangement which issued a series of *dit's* when one lever was pressed and *dah's* when the other was pressed. Speeds of thirty to forty words per minute were not uncommon. **Morse Code** operation or ***CW*** as it is known, has experienced wide acceptance. Even today, thousands of operators around the world regularly converse with people they have never seen or spoken to, through the power of the key.

SOME MORE MODERN RADIO EQUIPMENT

This section shows how far the hobby has progressed. Digital readouts, special audio filters and speech processing equipment. All these have been a great boon to the modern enthusiast. Some of these receivers have six or eight microprocessors inside to help manage its operation. Not all of these transceivers are for long distance. Today much of the amateur radio activity is on VHF and UHF bands, which will only travel short distances but provides a stable environment for sending video and data transmissions.

Ask about these radios, find out what their specialities are.

A WORKING AMATEUR STATION

We have set up this display to show what a working station looks like. Notice that there are several radio's to cover different parts of the spectrum. The Antenna Rotator control box is present to change the direction of the main antenna via an electric motor on top of the tower. If your antenna is directional, and you wish to contact say, Russia, you have to *point* it there first! (See our demo on directional antennas to which highlights the importance of direction control).

The display of cards on the wall of our working station are called QSL Cards. They are a kind of post card that is sent around the world as proof of a successful contact. Special awards are available to those who can demonstrate that they have contacted over one hundred countries. If you are keen, you can do it all over again on morse code!

THE CRYSTAL RADIO - THE SIMPLEST OF RECEIVERS

When a capacitor (condenser) and a coil of wire are placed together, some special effects take place. Radio signals will affect the capacitor in one fashion and the coil (inductors) in an *inverse* fashion. The point at which a radio wave affects both items *equally* is known as the ***point of Resonance***. The frequency of this **resonance** wi' vary if either the coil or the capacitor is altered. This *point of resonance* is also the frequency that will be matched to that of a local broadcast station in order to yield an audible signal.

Only one more thing is needed, a method of recovering the audio from the selected radio signal. This is called ***Detection***. Because the frequency of radio waves are well outside the range of human hearing, we must add a **detector** stage to the receiver. This will trap the slowly changing sound waves (music and voice) that are superimposed on the broadcast radio signal and steer it to a loudspeaker or headset for us to hear. A detector can be any *non-linear* device, that is to say a device in which an electrical signal will pass through it better in one direction than in the opposite direction. This effect can be observed across opposing faces of a quartz or germanium crystal. A 'cats whisker' is a pointing device to find the most *non-linear* face of the crystal. More advanced models of the Crustal Radio simply used the manufactured germanium diode to achieve this effect.

Because the simple Crystal Radio uses the power within the radio wave to drive the headset or loudspeaker, it takes a relatively strong signal to produce good reception.

MIXING TWO FREQUENCIES TOGETHER

This demonstration shows how two audio signals can be mixed together to create a **third** tone. It is a bit like listening to the sound of a twin engine aircraft. When the two motors are running at almost the same speed, the sounds **beats** together and produces a *third* note. The **Oscilloscope** shows visually how these different signals interact. Observe what happens when one signal is exactly two or three times higher than the other. These patterns are known as **Lissajous Patterns** and the action of mixing frequencies together to generate new frequencies is called **Heterodyning**. It is this process that takes place within the previously mentioned **Superheterodyne Receiver.**

MODULATING A SIGNAL WITH SOUND

The act of introducing sounds or information onto a radio wave is called **Modulation**. We can demonstrate this process on an oscilloscope using a simple AM transmitter. When the transmit button on the microphone is pressed, a continuous carrier wave is sent to the antenna. If any sounds are directed to this microphone while transmitting, the height or **amplitude** of the carrier wave is varied. This is called **Amplitude Modulation**, or **AM** for short. Our demonstration can show the effects of too little or too much modulation.

Another more recent technique for impressing sound waves onto a radio carrier wave is **FM** or **Frequency Modulation**. On **AM** the carrier wave frequency *never changed*. With FM transmissions the audio from the microphone is used to slightly alter the carrier frequency, but the height of the signal remains the same. A special decoder that is fitted to an FM receiver called a **Discriminator** can check for small shifts in carrier frequency and convert it back to normal sound.

We tend to think of AM and FM as different parts of the broadcast band. The reality is that both AM and FM will work on *any* frequency. It is only by convention that the **AM** band is on **530-1700 khz** and the **FM** band is on **88-108 mhz**. FM has the advantage of a far higher immunity to atmospheric noise than AM, hence the listener will experience clearer reception. Radio used aboard Aircraft is still on AM. This is not because it is better, but because there are so many aircraft radio's around using AM that no one has figured a safe way to make an international conversion to FM operation.

EVEN *LIGHT* CAN BE MODULATED...

A beam of light can be regarded as a kind of carrier wave. It is possible to vary the intensity of the beam with an audio signal. Our demonstration here shows a modulated laser signal shining on a small light sensitive component which is fed into an audio amplifier. We can then 'hear' the modulation superimposed on the light. This too is a form of AM transmission.

Spy's have been known to reflect laser light off windows in offices. The speech vibrations in the room modulate the glass slightly which serve to modulate the reflected laser light. If an amplifier and photocell can be positioned to capture laser light reflected from the glass, then any sounds in that room can be monitored.

THE DIRECTIONAL ANTENNA

Ever look at a TV antenna and wonder what all those bits of aluminium did? The theory is not as complicated as you may think. All radio waves travel at the speed of light, which is 300 million metres per second. Because of this relationship with the speed of light, the size or **wavelength** of a radio wave will vary with its frequency. Low frequencies have long wavelengths and require long antennas. High frequencies only need short antennas. Have you ever noticed that the metal elements on a UHF TV antenna are much shorter than the old VHF antennas. This is because UHF TV is broadcast on a much higher frequency. The basic antenna is called a **dipole**, which is a bit of wire extended in two directions from a coax cable, a bit like the old 'rabbits ears' antenna on top of the telly.

It was discovered in the fifties that if another metal element (Called a **Reflect**... is placed a little way behind the dipole, only 5% **longer**, then it will reflect some of the signal back to the dipole element thus *increasing* the strength of a signal from one direction. (It will proportionally *decrease* signals coming from behind the reflecting element. You don't get something for nothing!) If you were to add another metal element in *front* of the dipole, only 5% *shorter*, this will tend to focus the signal further onto the dipole. A simple analogy is a small lamp in a darkened room. Placing a mirror behind the lamp will make one wall brighter and the other more dull. Adding a lens in front of the lamp can further focus and concentrate the light. The bright spot on the wall is only an apparent gain, as the rest of the room is darkened. With directional antennas, we measure the forward gain in **decibels**.

Our small demonstration here shows how well a UHF CB receiver will respond to a fixed signal using a small three element beam antenna.

When you get home make sure that the *little* end of your TV antenna is pointing to Mt Dandenong.

A TOUR OF THE RADIO SPECTRUM

The frequency spectrum is vast. Some charts on display in this section attempt to put some kind of perspective on the spectrum for the man in the street. See if you can locate Cellular Telephones, Pocket Pagers, and the frequency reserved for Microwave ovens.

THE HIGH VOLTAGE POINTS ON AN ANTENNA

This is the last of our demonstrations. We have strung up a simple dipole antenna on 21 megahertz.

Question: When is a piece of wire *not* a piece of wire?

Answer: When there are radio waves on it!

This antenna is operating on a wavelength of **14.2 metres**. Because it is only a **half wave** dipole, we have made it only 7.1 metres long. Radio waves, like other electrical energy have **voltage** and **current** potential's. Along the length of a half wave dipole there are *high* voltage potential's at the ends and *low* voltage in the middle. Conversely, the currents flowing through the wire are *low* near the ends of the dipole *high* near the centre. When a fluorescent tube is held near an antenna while transmitting on it, the radio waves will ionise the gas within, causing it to light up. Note that the ionisation <u>only</u> takes place at the *high* voltage ends of the antenna.

A BIT ABOUT THE HOBBY OF AMATEUR RADIO

Amateur Radio has been around for most of the century. In fact, the Wireless Institute of Australia is the *oldest* radio society in the world and was founded in 1914. Today, amateur radio means different things to many people. Some will use it for communications around the world, some use it merely for local contacts. Others just use it as a medium to experiment with antennas and electronics. Wherever your interests lie, there is sure to be an aspect of Amateur Radio that will entice you.

Several different types of license category exist in Australia. The different categories will enable operators to use specific parts of the spectrum and transmitter output levels. There multi-choice exams that must be passed in order to gain a license. Everyone must pass a Regulations test. There are two grades of radio theory test which may be attempted (Novice or Full theory). There are also some Morse Code tests that need to be passed to access the lower frequencies that are used for overseas communication.

You do not have to be a technician or rocket scientist to pass these tests. Time has shown that anyone at all can attain a license with a little persistence and effort.

A BIT ABOUT OUR RADIO CLUB

The **Gippsland Gate Radio & Electronics Club** was formed in Dandenong in 1977. In 1992 we moved our meeting venue to Cranbourne. Since the day the Club was formed we have been actively promoting the hobby by organising projects, competitions, field trips, courses and the like. We have two meetings per month which are held at the Cranbourne Guide Hall, commencing at **8:15 pm.** (except for December).

On the first Friday of the month we have our Prac/project nights where the emphasis is on construction and education. On the third Friday of the month we have a general meeting and often supplement this with a guest speaker on an interesting topic. On several occasions each year we have outings such as camping trips, pub nights and radio oriented competitions. Full membership is $25 annually, with concessions for students and pensioners, this includes our monthly newsletter 'Gateway'. Visitors are welcome to attend any of our meetings. Tea and coffee is free.

WOULD YOU LIKE TO RECEIVE A COMPLIMENTARY NEWSLETTER?

Our first meeting for 1996 is on Friday the 19th of January. If you send the following details to **P.O.BOX 1098 CRANBOURNE 3977,** we will send a newsletter four days before the January meeting night as a reminder.

NAME ____

ADDRESS ________________________________ **P/CODE** ____