By RODNEY CHAMPNESS, VK3UG

The spark era - the beginning of radio

The turn of the 20th century marked the birth of radio but the techniques used were very different from the techniques of today (or even 20 years later). It was the beginning of the "spark era", with crude transmitters that relied on spark gaps and equally crude receivers.

AT THE TURN of the 20th century, radio or "wireless" (as it was known in those days) was very much in its infancy. Valves had not yet made their appearance and spark transmitters were the only transmitter format in existence.

Receivers started out with "solid state" detectors, coherers, galena crystal detectors and many other detectors of varying efficiency and ease (or was it difficulty?) of adjustment.

Wireless in the early 1900s was mostly used between ships and between ships and land stations. It was remarkable that in those early days, the receivers had no amplifiers at all and relied on the efficiency of the antenna, their tuned circuits and an earth to pick up signals. By using relatively high-powered spark transmitters, it was possible to receive signals hundreds and sometimes thousands of kilometres away.

If we were to connect a modern crystal set to a big antenna and an efficient earth like they did back in the early 1900s, we would obtain similar results. I know of a listener in Rockhampton who has listened to Radio Australia from Shepparton with a crystal set on 9MHz. The effective radiated power in that direction is of the order of five megawatts (5MW).

Spark era equipment

It is not often that you see genuine or even replica wireless equipment from the spark era. However, when I attended the 25th anniversary of the founding of the Historical Radio Society of Australia (HRSA), I came upon a display of just such equipment by Ian Johnston. Many collectors have very early crystal sets using galena crystals but few have equipment that pre-dates the common use of this type of detector in receivers.

Spark era equipment is a rarity and this article cannot seriously attempt to present anything other than a brief overview of this early radio gear and

A low-power spark gap transmitter from the early 1900s. The technology was crude by today's standards but signals from high-power transmitters could be received hundreds (and sometimes thousands) of kilometres away.

its usage. Spark era equipment is very different to the equipment that came later and radio technology had been completely transformed by the 1920s!

Basically, the 20-30 year time frame from the turn of the century saw enormous technological advances in radio, some of it driven by the needs of World War 1. Technology drove advances back then just as it does today.

Fundamental differences

During the spark era, diode and triode valves began appearing before World War 1. However, they were expensive, gave inconsistent results, were unreliable and had a short life. As a result, many believed they could not take those "new-fangled" valves seriously as by this time spark equipment was relatively reliable and was achieving consistent results.

There was also considerable resistance to the introduction of this "new" technology given that spark wireless technology was such a recent development and had become well established. However, history was to quickly prove them wrong – spark technology was destined to rule only from the time of Marconi's early experiments around 1894 to about the end of World War 1. After that, thermionic valve technology took over in just a few years. Even so, it's interesting to note that the Marconi School of Wireless in Melbourne still had a working marine spark transmitter (used for training purposes) as late as 1963.

Unlike spark transmitters, valve-type transmitters produce coherent signals, ie, signals which are on one frequency (the carrier wave). With modulation (eg, voice or music), the total amount of spectrum space occupied by a properly-adjusted transmitter is twice the highest audio frequency being transmitted.

For example, if the highest audio frequency is 10kHz, then the total frequency bandwidth is 20kHz.

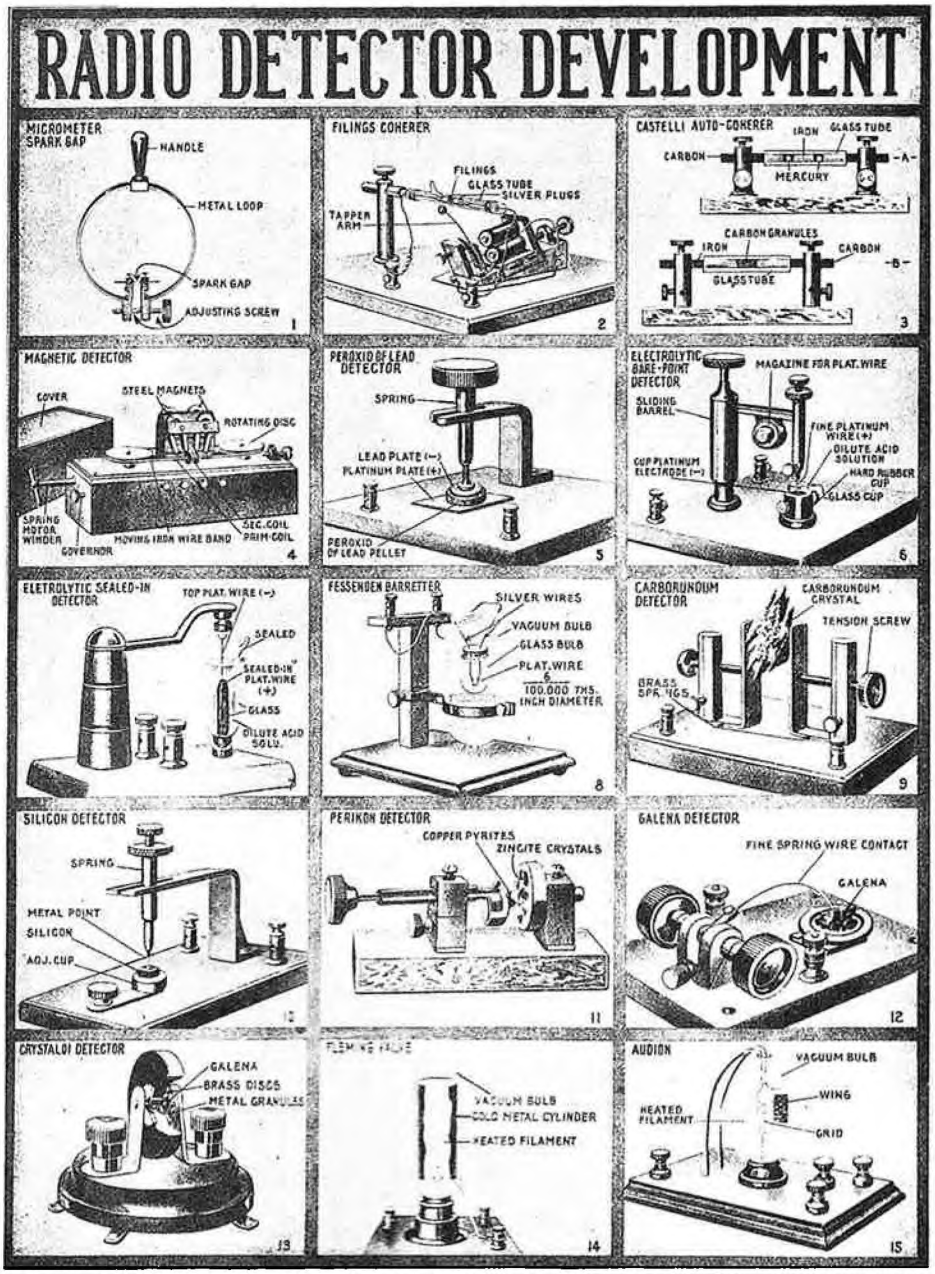
By contrast, spark transmitters

This rather strange looking device is all that remains of an old quenched spark gap transmitter.

Kevin Poulter To Contribute

For some time now, Kevin Poulter has been contributing to this column with his "Set Of The Month" panel. Recently, he has also agreed to write some Vintage Radio columns and these will begin appearing under his name in future issues.

Kevin is an active committee member of the Historical Radio Society of Australia (HRSA), has a keen interest in vintage radios and will be writing on a number of interesting topics.



Reproduced from *The Electrical Experimenter* (circa 1916), this page illustrates some 15 different devices that had been developed by the middle of WW1 to detect radio signals. Of these, the galena detector was widely used in crystal sets until germanium diodes became available.

(particularly the early ones) were wide-band, with non-coherent transmissions on almost all frequencies. The spark transmitter at the Marconi School of Wireless could be heard up to 13MHz, although its assigned frequency was 500kHz. Is it any wonder that spark transmitters were eventually banned?

Initially, spark transmitters had an untuned antenna connected to one side of a spark gap and the other to earth. There was no tuning. However, as spark transmitter technology matured and tuning circuits were added, the amount of spectrum used did contract.

Radio signal detectors

Reproduced with this article are a couple of pages of a publication called "The Electrical Experimenter" from around 1916. One page quite intrigued me and was titled "Radio Detector Development". It shows 15 different devices that can be used to detect radio signals.

Some of these we are familiar with and some we've probably never even heard of. One such device, called a "Micrometer Spark Gap", was used to detect and adjust the operation of a spark transmitter at close range.

The galena detector is much more widely known and was used in crystal sets until fixed-point contact germanium diodes became available. It was fiddly to adjust for a consistent, reliable signal which is why it was quickly superseded.

One that is really intriguing is the silicon detector. In its refined format today, it is the silicon signal diode such as a 1N4148. So a silicon diode was in use even 100 years ago!

Another detector that was commonly used in that era was the "coherer". The coherer usually had iron filings loosely filling a small space between two terminals. At rest, it exhibited quite a high resistance between the two terminals.

However, once a signal was detected, the resistance of the iron filings decreased dramatically as they "cohered" or aligned. The device then became useless as a detector when this occurred, so to get it back to its original state, a small device actuated by the change in resistance "tapped" the tube. This "de-cohered" the filings and reset the detector for the next Morse symbol dot or dash.

Naturally, this type of detector was only suitable for Morse code signals and was useless for radio signals.

The very early Fleming and Audion valves are also shown on the Radio Detector Development page. In fact, Edwin Armstrong developed the regenerative detector using the Audion and similar triodes. The regenerative detector held sway for many years as the preferred detector due to its extreme sensitivity compared to previous types of detectors.

A variety of other detectors including a magnetic detector, a peroxide of lead detector, an electrolytic bare-point detector, an electrolytic sealed-in detector, a Fessenden barretter, a carborundum detector and a perikon detector are also shown. During WWII, POWs even used rusty razor blades as radio signal detectors.

Spark transmitters

A variety of spark equipment is shown in the pictures I took at the 25th Anniversary HRSA display. The examples shown are all very early low-power transmitters and are similar to those commonly shown in museums, either as replicas or genuine original transmitters.

Most of these devices are the types used by early experimenters. As spark transmitters transmit on a very wide spread of frequencies, very little energy is transmitted on a single frequency (unlike valve transmitters). This reduced the available energy on the intended transmitting frequency, so the effectiveness of spark transmitters compared to valve transmitters was quite low.

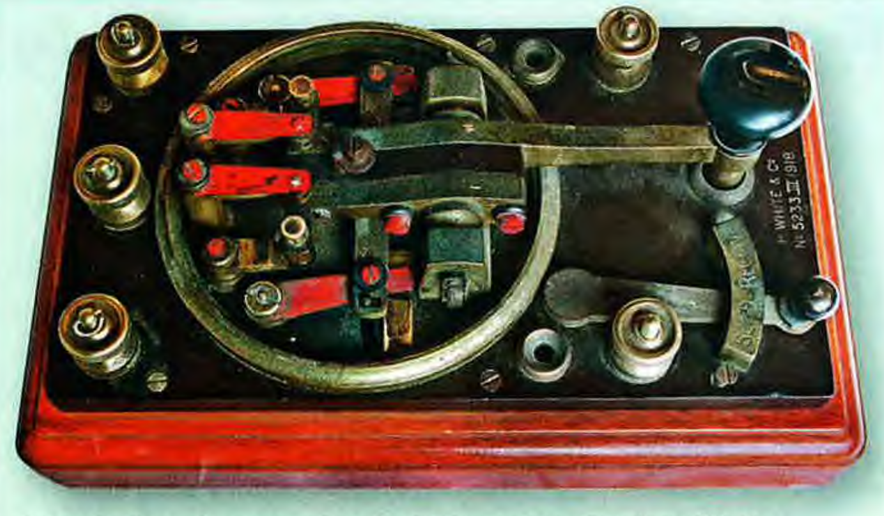
This meant that the transmitting range of low-powered units would not have been great – possibly only a few kilometres at most.

In addition, the frequencies used in the medium-frequency range from around 300kHz to 1500kHz require large antenna/earth systems if reasonable efficiency is to be achieved. On small suburban blocks, the radiating efficiency was probably not more than 2-5%.

By contrast, the commercial transmitting sites that were used to contact ships had huge antennas and often had their own power station to provide power to the transmitter. Some of these stations required input powers of 100kW or more.

The voltages used on the transmitters were also extremely high, often up around 10,000V. Have you ever wondered why early Morse keys had a round bakelite disc underneath the knob on the key? In most cases, it was there to prevent the operator from being electrocuted should his fingers slip off the key's knob.

Of course, the voltage across the key was much less than 10,000V but it was high enough for a careless operator to receive a lethal shock. Occupational health and safety concerns were not very high on the list in those days.



An early Morse key as used on land telegraph services (possibly the Overland Telegraph between Darwin and Adelaide).

Tuning up

In 1900, Marconi took out a patent for "Tuned or Syntonic Telegraphy". This invention introduced tuned circuits to radio technology and meant that a wireless set (radio) could be tuned to a particular frequency, just as is done today.

By using tuned circuits and further improving the designs, the effective output power from spark transmitters was increased dramatically. In addition, the ability of the receivers to detect weak signals was greatly enhanced. This in turn meant greatly increased range, thereby making radio communications much more effective and economic.

Spark gap design

The original spark transmitters simply produced a continuous spark across the spark gap for as long as the Morse key was pressed. This produced a "raspy" sound which sounded much the same from the receiver. If the spark was fed with mains power, it would also have a 100Hz or 120Hz audio component (depending on the mains frequency) in the signal.

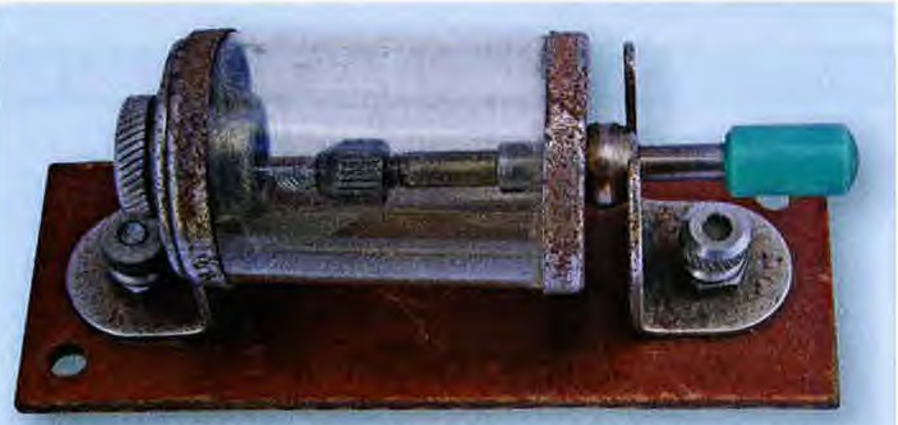
A few years after the development of the continuous-arc transmitter, the rotary spark gap transmitter was introduced. An example rotary spark gap is shown in the bottom righthand corner of the catalog page of the Manhattan Electrical Supply Company.

In this case, the mechanism consists of a number of studs with gaps between them. The system is somewhat like the distributor of a car – when the gap is small the spark jumps the gap and when it is larger, the spark is extinguished.

In operation, the distance between the points making the spark gap varies as the moving gap electrode is rotated by an electric motor. This means that the spark transmission will have a tone that relates directly to the number of times that the spark is made and extinguished each second.

This tone can be quite musical – or as musical as a spark transmission can be! The tone would have been in the hundreds of hertz, which is easily detected by both our ears and the headphones in use at the time.

Interrupting the spark at quite a high rate and reducing the mark-space ratio (ie, the overall time that the spark oper-



A galena crystal detector, as used in early crystal sets. They were fiddly to adjust to achieve a consistent, reliable signal.

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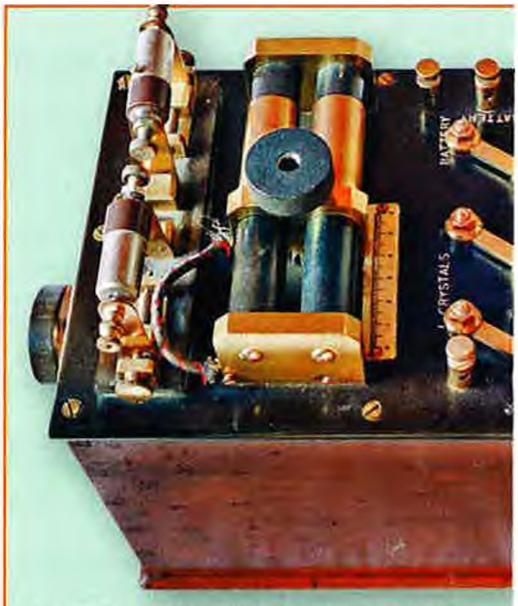
Also reproduced from *The Electrical Experimenter*, this page shows some of the equipment that was available during the spark era. Note the rotary spark gap transmitter at bottom right.



A spark-gap era dual-detector receiver system as used by the Royal Australian Navy.

ated) lowered the operating power. As a result, rotary spark transmitters were more effective and more efficient than earlier spark transmitters.

Spark gap erosion

There was considerable erosion of the gap points in both the original continuous and the later rotary spark transmitters. This problem was overcome with the development of the quenched spark gap transmitter.

In this device, the rotary gap was enclosed in a sealed chamber. After a short period of use from new, the oxygen in this sealed container was all used up and little erosion of the points then took place.

Other than that, the quenched spark transmitter was similar in concept to the rotary gap spark transmitter. There may have been other more **sophisti-**

cated spark transmitting techniques developed later on but I'm not aware of any.

Finding out more

Although our knowledge of the valve and transistor eras is quite extensive, the spark era is almost unknown and I for one would like to know more.

Unfortunately, old spark era equipment is almost impossible to obtain but there are bits and pieces around as can be seen in the photographs included with this article.

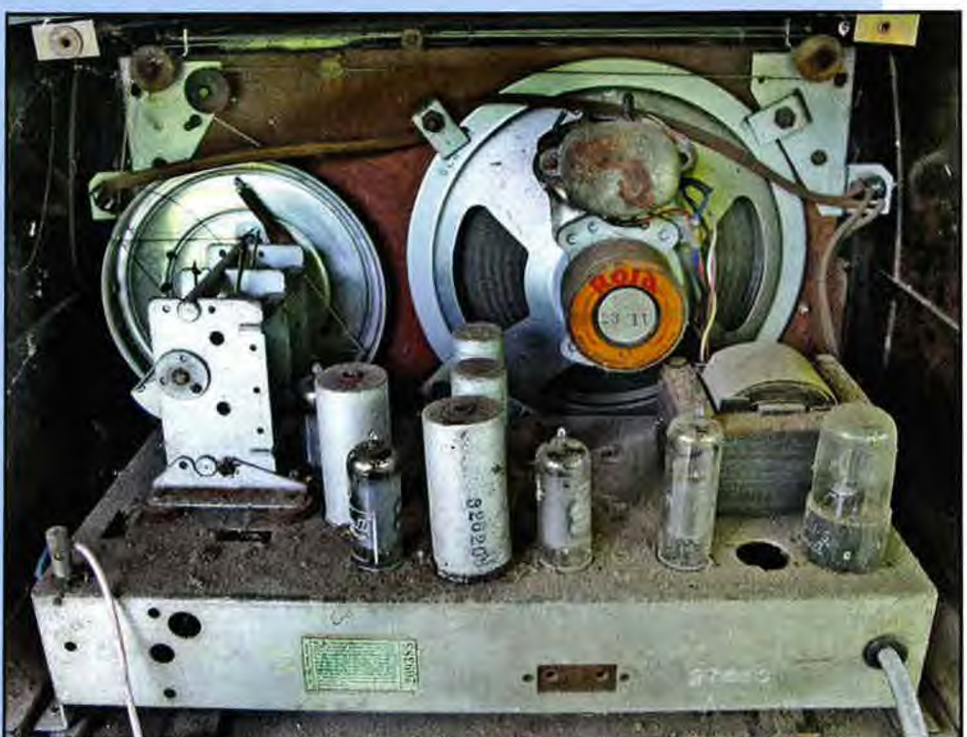
Old wireless books up to around 1925 will have information on spark transmitters and these should be grabbed before they are destroyed. The information in these will often be limited though, as a lot of the work was done by enthusiasts and experimenters in those days and is undocumented.

Ian Johnston is one of the few people around today who know much about spark era equipment and he was kind enough to allow me to view and photograph much of his equipment, as well as providing sources of information.

If you would like to hear what a spark transmitter sounded like, try this website: **www.physics.otago.ac.nz/ursi/belrose/sparkx2.AIFF**

Finally, further information on the spark era is available on **www.rod.beavon.clara.net/spark.htm**. Peter Jensen's book "In Marconi's Footsteps" is worth looking at too if you can find a copy. **SC**

Photo Gallery: Philips Radioplayer 124



MANUFACTURED around 1950, the Philips Radioplayer 124 was a 5-valve mantel set in a Bakelite cabinet. It employed a fairly standard superhet circuit with 455kHz IF stages and covered both the broadcast band from 530-1620kHz and the shortwave bands from 5.9-18.4MHz. The valve line-up was as follows: 6AN7 frequency converter, 6N8 IF amplifier, 6N8 detector plus AGC & first audio stage, 6M5 audio output stage and a 6X5GT rectifier. In this set, the speaker transformer laminations are connected to the HT (B+) line but the unit was normally rendered safe by the transformer core being pitch-encapsulated inside the housing. The above photos show an unrestored unit.