Before Valve Amplification - Wireless Communication of an Early Era

by Lloyd Butler VK5BR

At the turn of the century there were no amplifier valves and no transistors, but radio communication across the ocean had been established. Now we look back and see how it was done and discuss the equipment used.

(Orininally published in the journal "Amateur Radio", July 1986)

INTRODUCTION

In the complex electronics world of today, where thousands of transistors junctions are placed on a single silicon chip, we regard even electron tube amplification as being from a bygone era. We tend to associate the early development of radio around the electron tube as an amplifier, but we should not forget that the pioneers had established radio communications before that device had been discovered. This article examines some of the equipment used for radio (or should we say wireless) communications of that day.

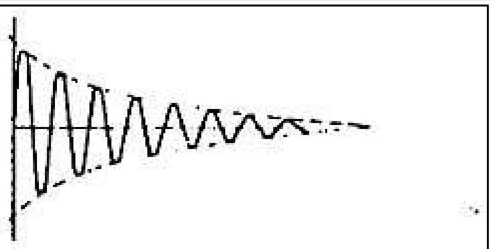
Discussion will concentrate on the equipment used and associated circuit descriptions rather than the history of its development. Anyone interested in history is referred to a thesis The Historical Development of Radio Communications by J R Cox VK6NJ published as a series in Amateur Radio, from December 1964 to June 1965.

Over the years, some of the early terms used have given-way to other commonly used ones. Radio was called wireless, and still is to some extent. For example, it is still found in the name of our own representative body, the W1A. Electro Magnetic (EM) Waves were called hertzian waves or ether waves and the medium which supported them was known as the ether. A tuning coil was called a jigger and a capacitor was a condenser. A wireless operator was known as a Sparks and we now seem to have graduated from cycles-per-second to Hertz.

Some of the explanations given in the text are modified extracts from references used and some licence is taken in using terms, both old and new.

DAMPED WAVE TRAINS

Signals generated for transmission of wireless telegraphy, in the early years, were in the form of Damped Wave Trains, as illustrated in Figure 1. A tuned circuit, coupled to the aerial was shock excited into oscillation by rapidly discharging a capacitor (part of the tuned circuit) at repetitive intervals, usually corresponding to a repetition rate equal in frequency to a sound in the human hearing range. For each discharge, a wave train was generated, decaying in amplitude as each resonant cycle transferred energy to the aerial. The resonant frequency of the tuned circuit, partly formed by the aerial, set the frequency of transmission.



A Damped Oscillation in a Single Circuit.

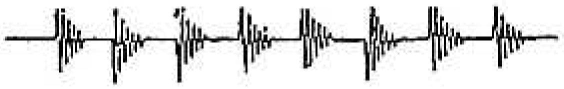


Figure 1 — Oscillogram of Damped Electric Spark Waves.

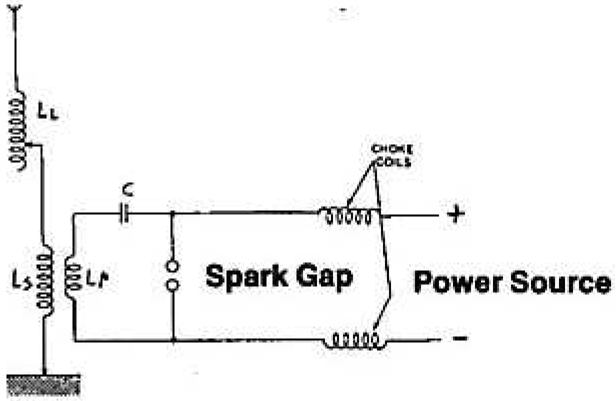


Figure 2 — Basic Spark Transmitter.

QUENCHED SPARKS

On reception, the detected output either actuated a telegraph recording device or was coupled to a telephone receiver to generate an audible buzz at a frequency related to the wave train repetition rate.

The reason for generating damped waves can be appreciated when thought is given to what is needed to generate continuous waves. To generate these, the energy lost in the tuned circuit must be continuously replaced at each cycle, these days achieved by feedback through an amplifier, the device the pioneers did not have until DeForrest developed the triode valve. Notwithstanding this, the pioneers did find ways of generating continuous waves (without valves) as we shall see later.

Returning to our damped waves, the basic circuit for generating these is the spark transmitter (see Figure 2). Capacitor C is charged from the power source until it develops a voltage sufficient to break-down the spark gap. At this point in time, capacitor C is connected, via the spark gap, across primary inductance Lp and its energy is released to the tuned circuits made up of C, Lp, Ls and the aerial reactive components. The dampened wave train is commenced as energy and is continuously lost in radiation via the aerial. The wave train repetition rate is controlled by the time constant of the charge circuit, largely the capacitance of C and the impedance of the choke coils and power source.

In the design of spark transmitters, a great deal of attention was given to quenching of the spark, that is, the spark had to be quickly extinguished once the tuning system had been set-up in oscillation. The reason for this can be explained by considering the theory of mutually coupled tuned circuits. If two circuits, tuned on the same frequency, are coupled together and set in oscillations, energy is transferred from one to the other to an extent determined by the coefficient of coupling (K). If K is low, coupled energy is small and one resonance occurs at a common resonant frequency. If the coefficient of coupling Is increased beyond a value, called critical coupling, two resonant peaks occur (refer Figure 3).

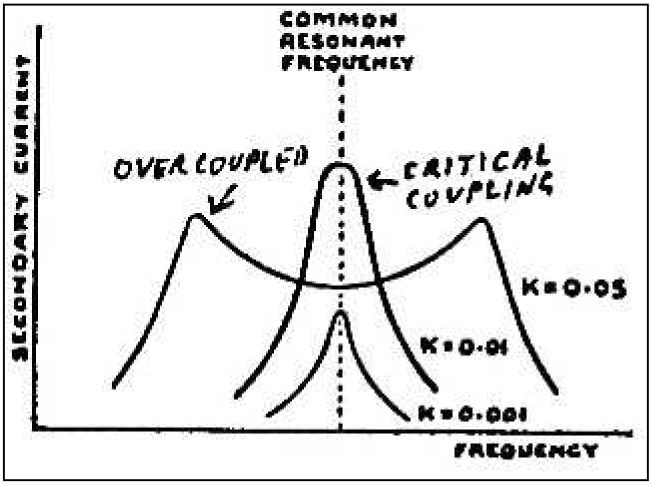


Figure 3
Effect of Over-Coupling

Referring again to the spark transmitter circuit of Figure 2, there are two tuned circuits mutually coupled, one formed by the transformer primary Lp and its resonating capacitor C and the other formed by secondary Ls and the aerial circuit reactance. Tight coupling beyond critical value is necessary to ensure maximum transfer of energy from primary to secondary and hence there are two resonant frequencies which can be transmitted.

Returning to the discussion on the spark quench, this in effect disconnected the primary tuning capacitor from the transformer primary immediately following the spark discharge, so that resonance occurred singly in the aerial resonant circuit to prevent transmission of a second frequency.

A further function of the spark quench was to improve the efficiency of the circuit. If the spark had been allowed to be sustained during the whole oscillation train, additional power would have been lost in the primary circuit through the spark gap.

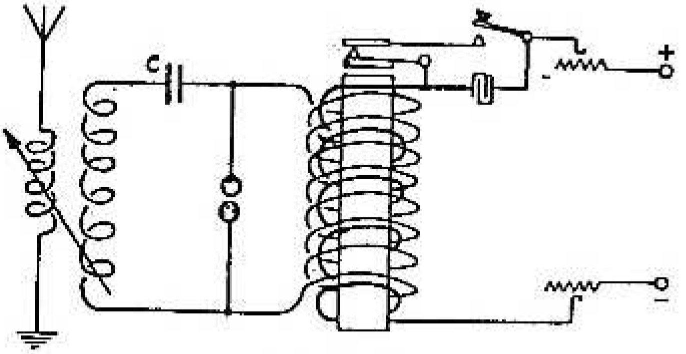
SPARK TRANSMITTERS

High power spark transmitters were used for many years in wireless stations on shore and on ships. Some transmitters were still in use as emergency equipment on-board ships in the years well after World War 2.

There were a number of variations in spark transmitter designs concerning the method of charging the capacitance from the power source, the type of power source and the method of quenching the spark gap. We shall discuss a number of these.

THE INDUCTION COIL

The induction coil was used as the power source for low power spark stations operating from dry cells or accumulators. It provided a means to generate the high voltage necessary to energise the spark gap from the low voltage battery source. A circuit diagram is illustrated in Figure 4.



Induction Coil.

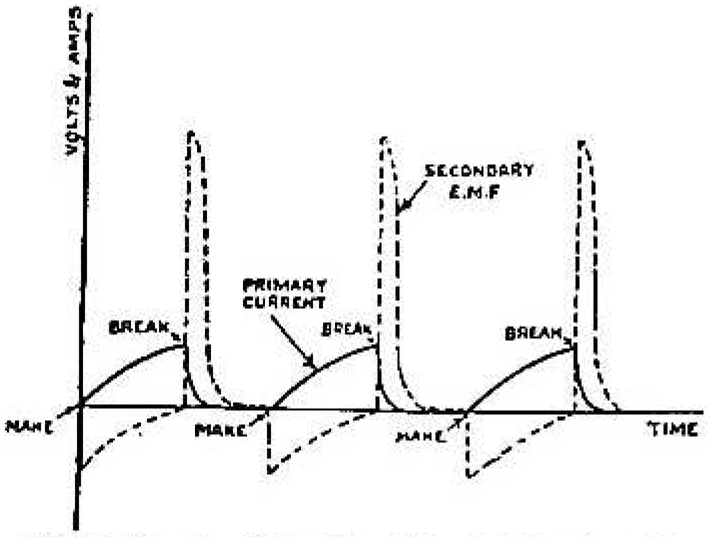
Figure 4
Spark Transmitter with Induction Coil (Ref. 6)

The induction coil consisted of a primary coil of thick wire wound with a number of turns on an iron core composed of a bundle of soft iron wires. The secondary consisted of many turns of fine wire so that a very high voltage step-up was achieved. In series with the primary winding was the interrupter consisting of a soft iron armature, secured to the top end of a flat steel spring whose tension could be adjusted by means of an adjusting screw. Action is as follows:

When the key is pressed, a current flows through the interrupter contacts and the primary winding. The core is magnetised and the armature is attracted to it. The contacts are therefore suddenly separated and the current through the primary rapidly falls to zero. As soon as the primary current has died away, the armature is released and contacts are again made, re-organising the primary to repeat the cycle of events. The cyclic time constant sets the spark train repetition rate.

Across the contacts, a time capacitor controls the rise and fall of current to reduce arcing across the contacts and improve circuit operation.

At contact break, a high voltage is developed in the secondary coil as shown in Figure 5, and this is used to charge capacitor C for the initiation of each spark discharge and start of a wave train.



Primary Current and Secondary Voltage in Induction Coil.

Figure 5.
Primary Current and Secondary Voltage in Induction Coil. (Ref. 6)

ALTERNATOR AND TRANSFORMER SYSTEM

The most universal practice for energising spark oscillating circuits of half-kilowatt spark transmitters and larger units, was to use an alternator or rotary converter with its AC output voltage stepped-up via a transformer to a value sufficient to break down the spark gap.

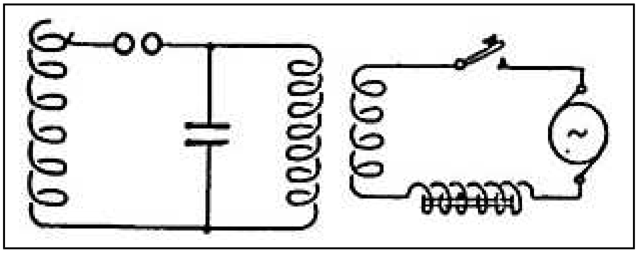


Figure 6
The Alternator and Transformer Methods. (Ref. 6)

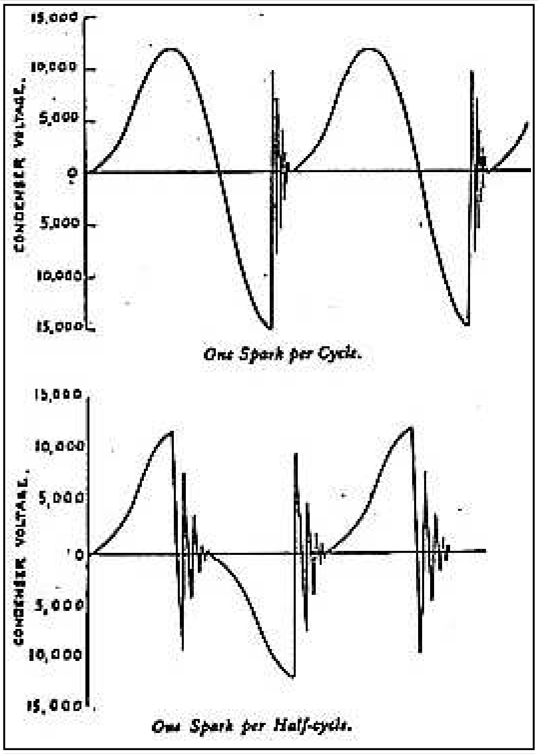


Figure 7 - Spark Train Frequency. (Ref. 6)

A typical energising circuit is shown in Figure 6. The inductance in series with the alternator controls the power taken from the alternator and together with the tuning inductance, limits the charge rate of the capacitor.

Depending on the adjustment of the spark gap relative to the AC voltage applied, either one spark per half AC cycle or one spark per one AC cycle, takes place. This is illustrated in Figure 7. The spark train repetition frequency is therefore either twice the alternator frequency or equal to the alternator frequency.

A number of methods have been used to quench the spark. On some transmitters, a special quench gap (QG) was used which rapidly cooled the spark. The spark gap was broken up into a number of very short gaps in series and used electrodes made of metals which were good heat conductors, coupled to radiating fins to dissipate the heat to the surrounding air. Forced air cooling was also sometimes used.

Another method was to use a rotating spark gap consisting of a metal wheel carrying a number of studs or spokes projecting from its edge and which rotated between two fixed spark electrodes so that the spark duration was controlled.

Rotating spark gaps were classified as either synchronous or asynchronous types. The synchronous type was coupled to the shaft of the alternator which supplied power to the oscillating circuit so that the spark was synchronous to the alternator frequency and phased to coincide with maximum voltage across the charging capacitor in the tuned circuit.

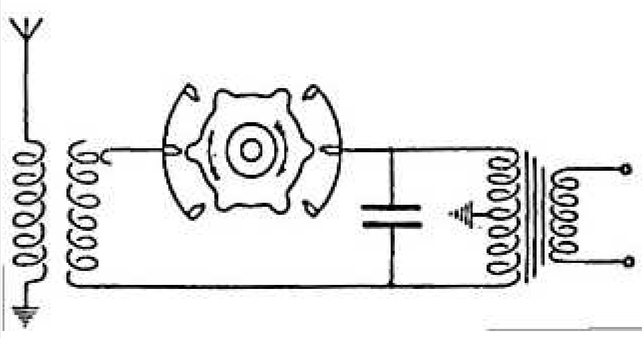


Figure 8 - Asynchronous Rotary Gaps (Ref. 6)

In the asynchronous type, as shown in Figure 8, the speed of rotation of the gap was independent of the speed of the alternator. In this system, some sparks were missed when timed at the low voltage phase of the alternator cycle (refer to Figure 9). The advantage of this system, however, was that the alternator could be run at a lower frequency than the wave train repetition frequency, the latter being controlled by the rotating gap rather than the alternator speed.

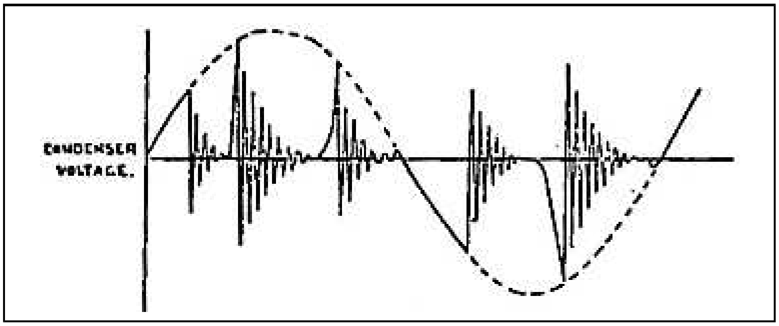


Figure 9
Condenser Voltage with asynchronous Rotary Gaps. (Ref. 6)

In transmitters which employed no special spark quench circuit, it was necessary to reduce coupling and detune the aerial circuit to prevent transmission of two frequencies. This was done at the expense of reduced power output coupled to the aerial.

Examples of quench gap (QG) transmitters are shown in Figures 10, 11 and 12.

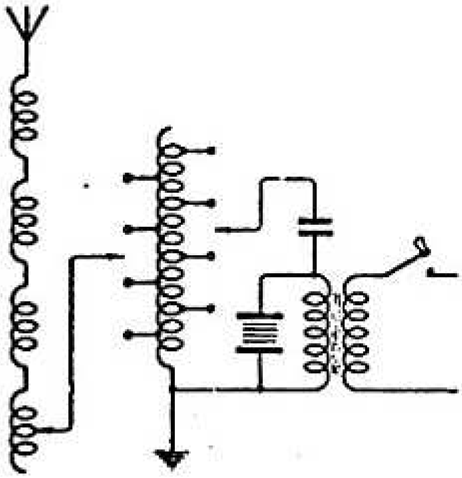


Figure 10 - Siemens 1/4kW OG Transmitters. (Ref. 5)

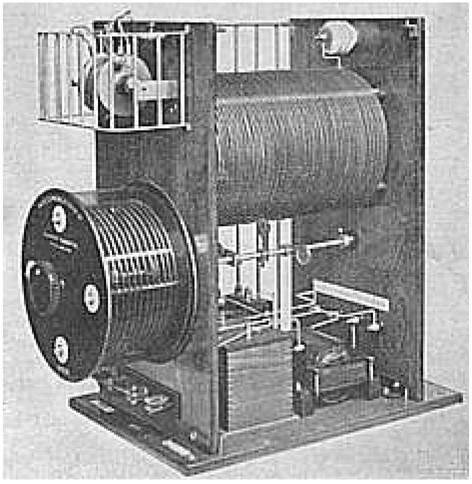


Figure 11
Radio Communication Co, Type T24, 1/4kW QG Transmitter. (Ref. 5)

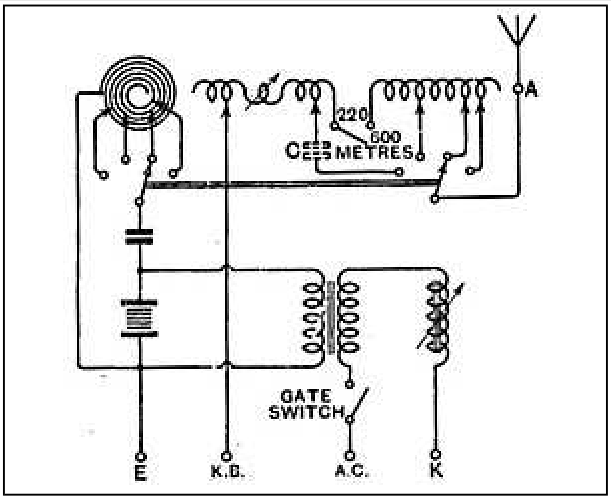


Figure 12
Wiring Diagram of 369 QG Transmitters.(Ref. 5)

WIRELESS TELEGRAPHY RECEIVERS

This segment will examine some of the devices used to detect the transmitted signals. There were no amplifying devices as they are known today, and the signal level fed to the detector was that received from the aerial system. The detector was connected via a single tuned circuit and hence there low selectivity or poor ability to reject unwanted signals, close in frequency to that being used.

FILINGS COHERER

The earliest form of detector to give good results was the filings coherer, so named because of the discovery that in the presence of a high frequency alternating current, metallic filings tend to cling together or cohere.

The coherer is illustrated in Figure 13. The small glass tube is exhausted of air. The terminals TT are connected to silver plugs SS, which are separated by the nickel and silver filings. A DC circuit connects the coherer to a relay which controls a Morse inker or relay. The coherer is also connected via the tuning system to the aerial. With no signal input from the aerial, the filings have low conductivity, but when a signal from the aerial flows through the coherer, the filings cohere and increase conductivity so that the relay is energised.

A problem with the coherer was that after each wave train had passed through it, the device had to be de-cohered by means of a tapper to shake-up the filings to restore low conductivity. The apparatus to do this is not shown in the diagram. A further problem was that the coherer was easily upset by atmospheric static.

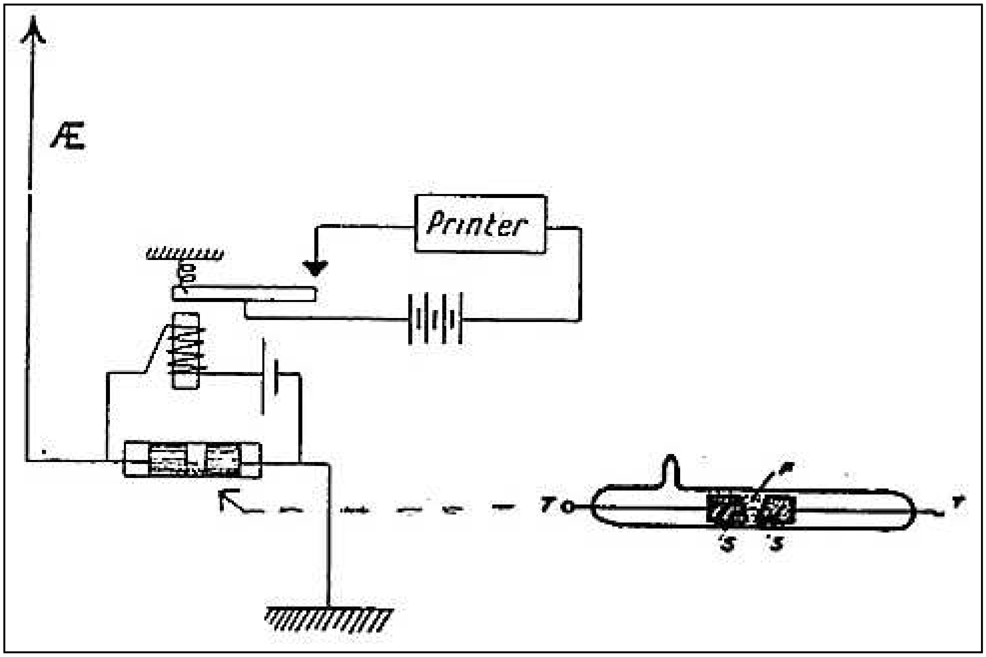


Figure 13 - Filings Coherer and Receiving Apparatus (Ref.1)

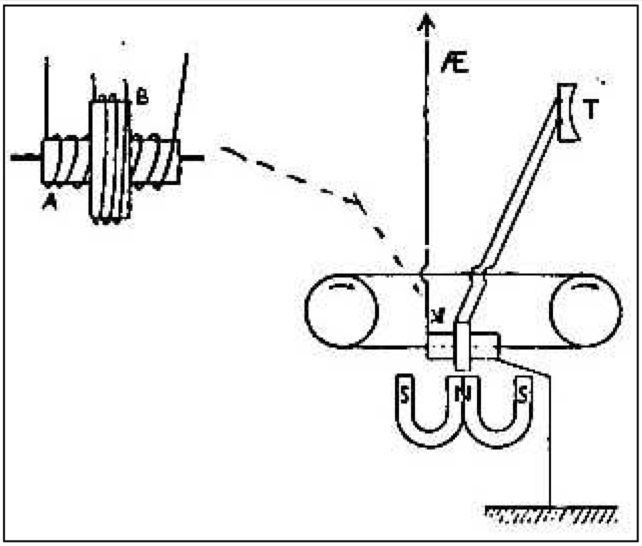


Figure 14 - Magnetic Detector. (Ref. 1)

THE MAGNETIC DETECTOR

Marconi is accredited with having made a great advance in detection with his invention of the magnetic detector (refer Figure 14). Two mutually coupled coils are located in the static magnetic field of a permanent magnet. One coil (A) is connected via the tuning system to the aerial and the other coil (B) is connected to the telephone receiver. The magnetic field is concentrated by an endless band of iron wire which passes through the coils and during operation, rotates continuously through them. Operation is as follows:

When a magnetic field is removed from soft iron, there is a lag in the collapse of the field or what is generally called hysteresis. Because of this effect, the magnetic field in the wire is dragged along, past the normal field of the magnet, by the movement of the wire.

When a signal is received, a high frequency alternating magnetic field is developed from signal current in coil A. This reduces the hysteresis effect and hence increases the strength of the field from the magnet passing through coil 8. A change in field strength through coil B develops a voltage at B so that each time a wave train is received, the telephone receiver is actuated, generating sound.

The maggie as this detector was called, was a decided improvement over the filings coherer and was used as standard Marconi equipment for many years. Though not more sensitive than the coherer it was rugged, reliable and much faster in operation.

THE CRYSTAL DETECTOR

A further development was the mineral or crystal detector consisting of a piece of crystalline carborundum or crystal-line silicon with a metal point contact as shown in Figure 15. This device conducted current more readily in one direction than the other and was the forerunner of the modern point contact semiconductor diode, the operation of which is now explained by solid state theory.

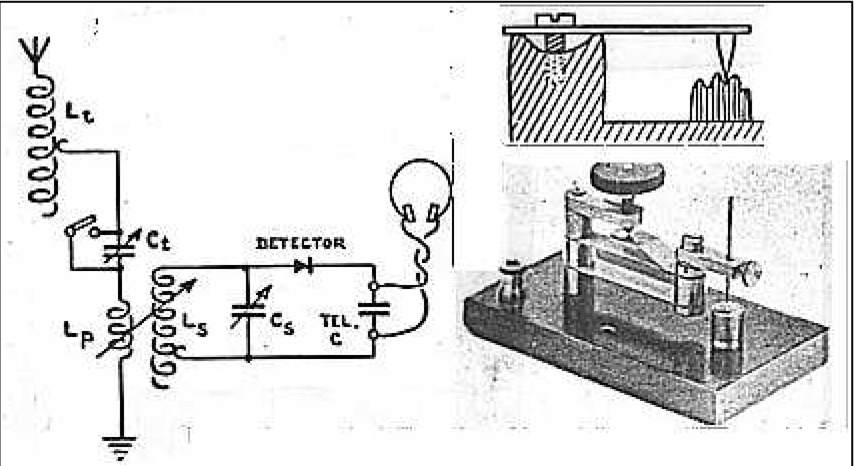


Figure 15 - Crystal Detector. (Refs. 1 & 6)

Every amateur radio enthusiast knows how a crystal radio receiver operates. Rectification by the crystal detector produces an RFcomponent superimposed on a DC component. When the amplitude of the RF signal varies with modulation or the spark wave train, the DC component changes with it. A low pass filter formed by the headphone impedance and a bypass capacitor removes the RF component leaving the demodulated signal which drives the headphones.

Another way to explain the process is to consider the RF signal as a carrier plus sideband components. If these are fed through a non-linear device, such as our detector, difference frequency components are developed between the carrier and the sideband frequencies. These demodulated components are separated from the RF frequencies by the low pass filter and are audio frequencies related to our spark train repetition frequency or speech in the case of a radio telephony signal.

Another device used by the pioneers was the electrolytic detector. This also operated in a non-linear mode in that its resistance varied as a function of the signal current fed through it. This device will be considered further when reception of radio telephony is discussed.

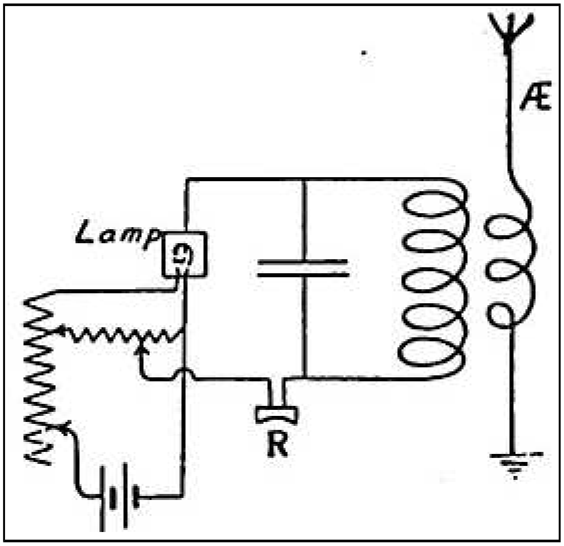


Figure 16 - Fleming Valve Detector. (Ref. 1)

The last receiver circuit for the present, shown in Figure 16, uses the Fleming valve detector, or as we know it, our diode valve detector. It was Edison who first discovered that if a heated element and a metal plate were both placed in an evacuated envelope, current would flow in one direction, but not in the other. The diode valve was first used by Fleming for rectification in the detection process and it remained as a widely used detector in TRF and super-heterodyne receivers of a later era, until semi-conductor devices replaced valves as amplifiers and rectifiers.

WIRELESS INSTALLATIONS

This section will examine some early wireless station installations shown in Figures 17-23. A typical early ship installation is shown in Figure 17. In general, ships operated on frequencies below one megahertz in what is known today as the medium frequency (MF) band. For long distance communication, frequencies as low as 30kHz (approximately 9000 metres) were used in the now low frequency (LF) band. Figure 22 illustrates the massive aerial systems needed to operate at these long wave lengths.

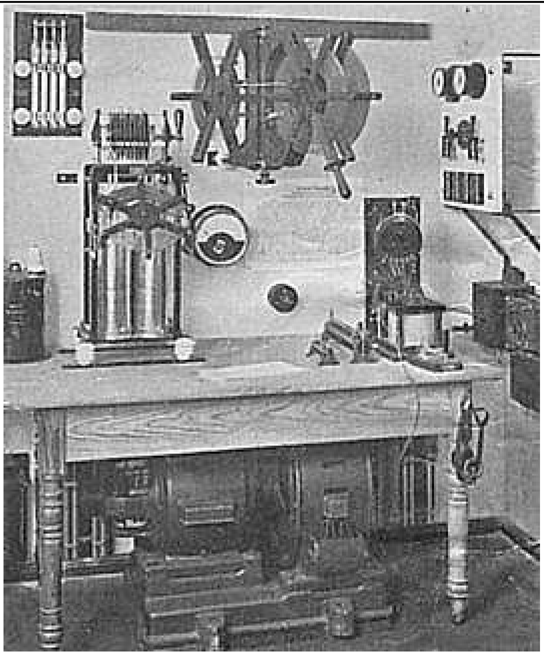


Figure 17 Standard Ship Set, (Ref 1)
Antenna Energy 1.5kW. Telefunken System.

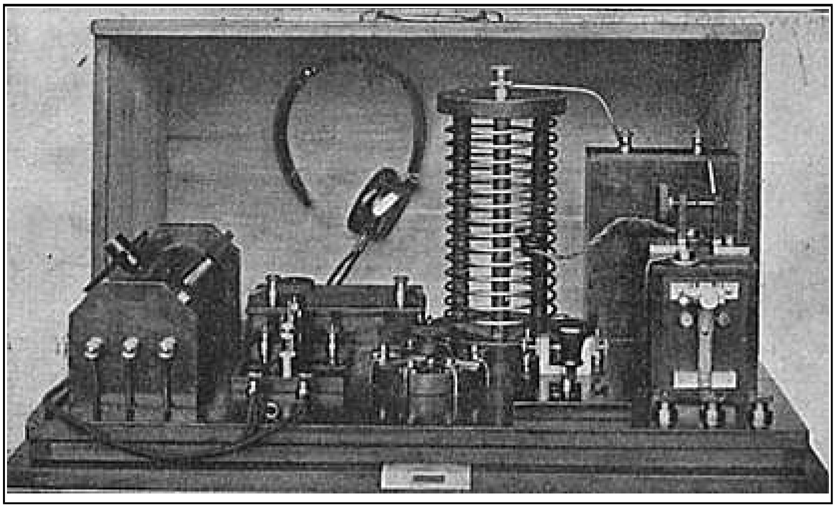


Figure 18 - Very Small Portable Wireless Station. (Ref. 1)

Figure 18 shows a low power portable wireless station using an induction coil as the spark transmission source.
Figure 20 is an interesting photograph of a portable field station for cavalry. It has a dynamo driven by a petrol engine mounted on a saddle.

An early submarine fitted with a large aerial structure is shown in Figure 23. According to the source from which this was obtained, the structure had to be collapsed when the submarine was submerged.

Figure 19
Interior of Station at Suva, Fiji Islands. (Ref. 1)

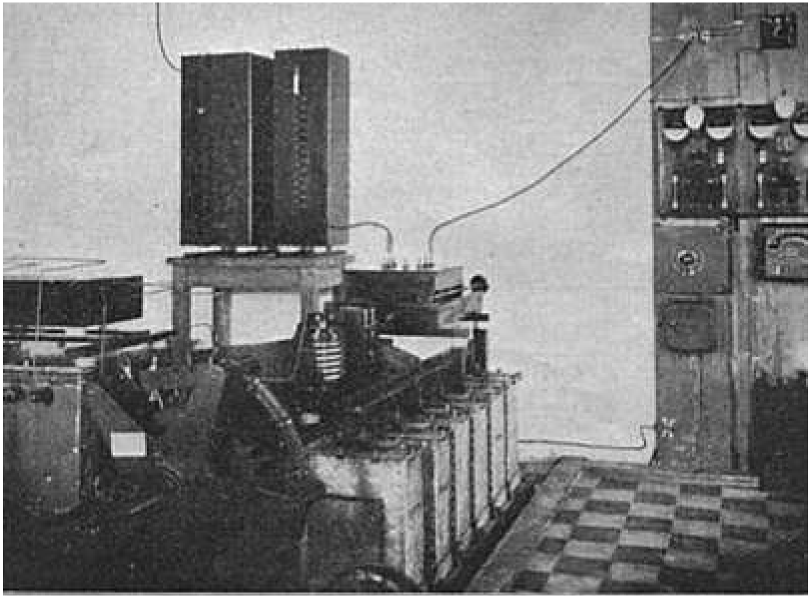


Figure 20
The Rotary Spark Gap, Oscillating Transformer, and Inductances, Athens Station. (Ref. 1)

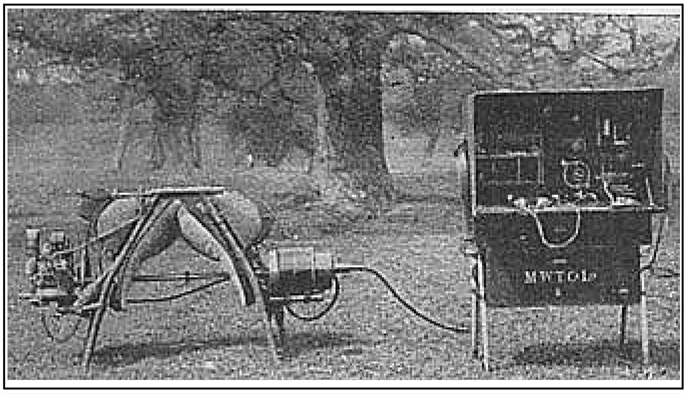


Figure 21
A Portable Field Station for Cavalry (Ref. 2)

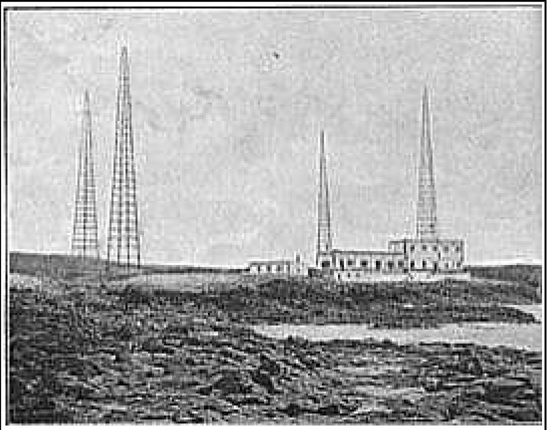


Figure 22 - The Lea Palmas Station (Ref. 1)

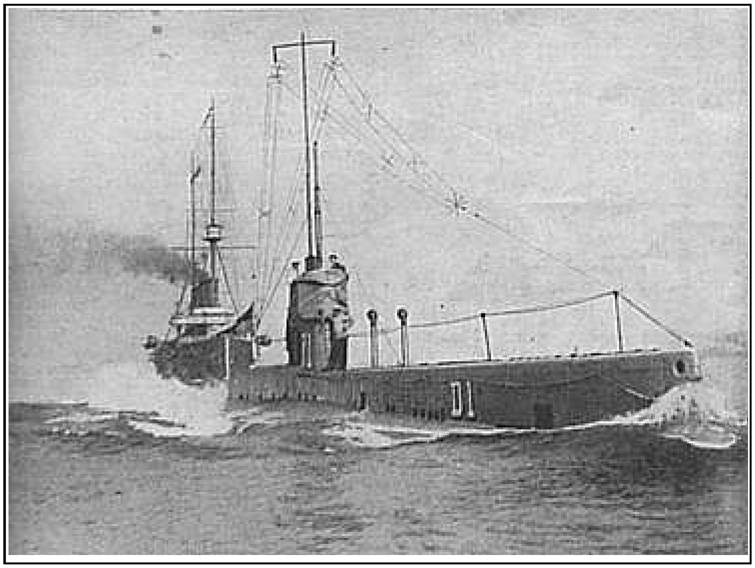


Figure 23
Wireless Aerial on a Submarine and HMS Drake (Ref. 2).

CONTINUOUS WAVES

Methods for generation of continuous waves were first discovered by Professor Elihu Thompson and ultimately developed for wireless telephone purposes by Professor R.A.Fessenden using a high frequency alternator coupled directly to the aerial system. Development of special alternators was carried out by a Swedish engineer E.F.W.Alexanderson.

The original alternator supplied power of about one kilowatt at a frequency of 80kHz. Around the period of World War 1, alternator transmitters had been built and put into commercial operation with power as high as 200kW This was high power by any standards.

The discovery of the singing arc by Duddell in 1900, opened up a new and promising field for continuous wave transmission, especially for telephonic purposes. He found that under certain circumstances, the electric arc could be set in a state of continuous high frequency oscillation, the frequency depending on the proportion of inductance and capacity inserted in a branch or short circuit of the arc (refer Figure 25). Burning in air, the frequency was limited to about 40kHz maximum and the system was further developed by Poulson who discovered that the frequency could be raised by forming the arc in hydrogen or hydrocarbon gases under high pressure. Cooling one of the arc poles with water to keep it cool was also found to be important.

The gases were used because of their high heat conducting power and to make the cooling effect still greater, the arc was formed between the poles of a strong electro-magnet. By repulsion of the electrofied gas, the magnetic field caused rapid circulation of the gas around the electrodes. Using the Poulson system, frequencies as high as one megahertz were achieved compared to 100kHz for the alternator system.

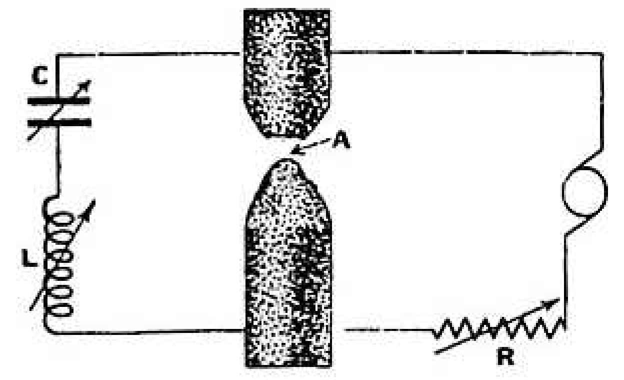


Figure 25 - Arrangement of Duddell ARC.
There are really two circuits in this arrangement, one carrying oscillating current, the other direct current.
Direct and alternating current are carried at the same time by the arc and the carbons.
All the constants in the circuit being correct, the arc A will give a musical note. (Ref. 3).

Again referring to Figure 25, the action of the singing arc is explained by Dr J A Fleming, as follows:

If a condenser in-series with an inductance of low resistance is placed as a shunt across the arc, the first effect is to rob the arc of some current to charge the condenser. This action however does not decrease, but increases slightly the potential difference of the carbons. Hence the condenser continues to be charged. When the charge is complete, the current through the arc is again stationary and the condenser at once begins to discharge back through the arc. This however increases the current and decreases the potential of the carbons, hence the action proceeds until the condenser is discharged.

In the circuit these are really two circuit paths, one carrying an oscillating current and the other a direct current. The former is the circuit CLA, whilst the latter is the circuit of the generator and RA. The arc A thus carries both direct current and high frequency alternating cu~rent at the same time.

The actions of the singing arc are also explained by Duddell to be dependent upon the fact that the arc itself must be regarded as having a negative resistance. That is to say, that at any moment, the instantaneous change in volts divided by the corresponding instantaneous change in amperes in the circuit ACL, must be a greater value than the resistance of the circuit and negative in sign, so that in each cycle the current builds up whilst the voltage decreases. Of course, these same conditions are necessary to maintain continuous oscillation in any oscillating circuit, be it valve, transistor or whatever.

A typical installation in the Eiffel Tower in Paris is shown in Figure 26.

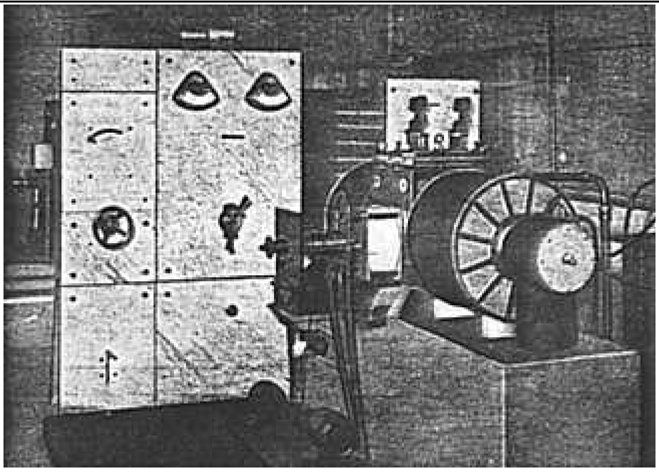


Figure 26
The Eiffel Tower Arc Transmitting Station. (Ref. 3)
On the right Is the Poulsen 60kW arc transmitter.
The powerfull electro-magnets are used for steadying the arc.

To the left of the machine is the control panel.
The electrodes of the arcs consist of a carbon cathode and copper anode.
The electrodes are in a water-cooled chamber.

The circuit of a Poulsen arc transmitter is shown in Figure 27,

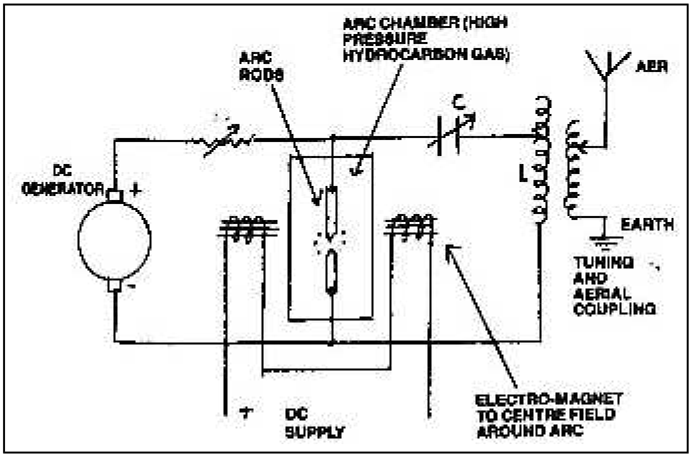


Figure 27 - Poulson-type Arc

Another form of transmitter used with considerable success was the majorana hydraulic transmitter. The operation of this was based on the capillary properties of jets of liquid and the device was made up of a small glass tube from which spurted a jet of acidulated water under steady pressure. The glass tube was connected to the diaphragm of the transmitter with an elastic envelope and the jet of water fell between two platinum plates. With a steady jet, there was constant resistance between the plates, but if the diaphragm was made to oscillate from a sound source, the resistance between the plates, controlled by the jet, was varied.

Other wireless telephoning systems have made use of the singing arc. Professor Ruhmer used a series connection of 12 arcs, each having a carbon and copper pole, the latter being kept cool by circulation of water inside. The arcs in this case were not enclosed; or under pressure. The arcs were operated at a current of four amps, at a voltage of 440 volts and the operating frequency was 400 kHz. Figure 30 shows the transmitter system used. The 12 series arcs are shown as one in the diagram. Amplitude modulation is achieved by coupling the output of a carbon granule telephone transmitter into the arc circuit via a transformer in order to modulate the current through the arc.

The actions of the singing arc are also explained by Duddell to be dependent upon the fact that the arc itself must be regarded as having a negative resistance. That is to say, that at any moment, the instantaneous change in volts divided by the corresponding instantaneous change in amperes in the circuit ACL, must be a greater value than the resistance of the circuit and negative in sign, so that in each cycle the current builds up whilst the voltage decreases. These same conditions are, of course, necessary to maintain continuous oscillation in any oscillating circuit, be it valve, transistor or whatever.

WIRELESS TELEPHONY

The wireless telephone transmitter used by Professor Fessenden is illustrated in Figure 28.

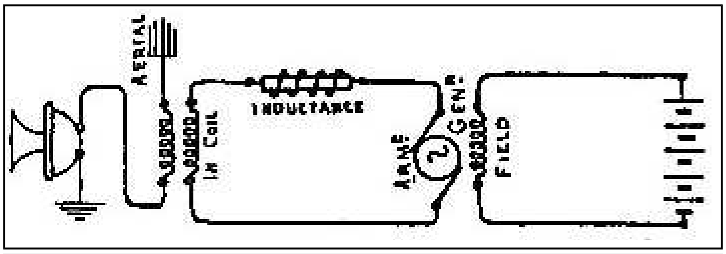


Figure 28
Transmitting Station,
Fessendon's Wireless Telephony (Ref 4)

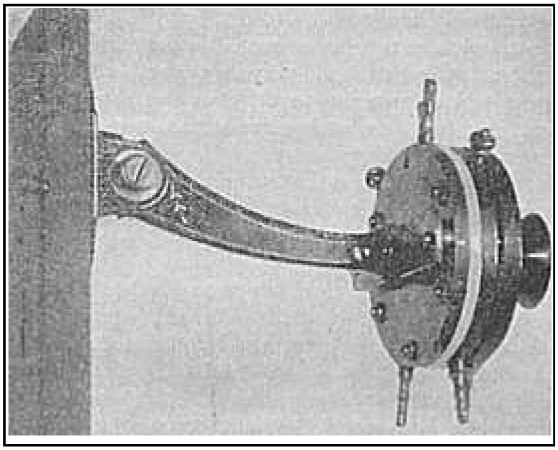


Figure 29
Fessendon's Wireless Trough Carbon Transmitter (Ref 4)

The carrier frequency is generated from a high frequency alternator and amplitude modulation of the continuous waves is achieved by passing the aerial current through a solid back carbon granule telephone transmitter so constructed that it could carry a very heavy current without overheating. Sound at the telephone transmitter diaphragm varied the resistance of the granules and hence the loss resistance in the aerial circuit.

In one form, the heat generated was dissipated by constructing the carbon chamber with two deep grooves so as to obtain a large air cooling surface. In a later and more satisfactory form, called the trough transmitter, the same objective was achieved by circulating water through a water jacket surrounding the carbon chamber. This form, shown in Figure 29, could carry as much as 15 amps of RF current continuously.

Another form of transmitter used with considerable success was the majorana hydraulic transmitter. The operation of this was based on the capillary properties of jets of liquid and the device was made up of a small glass tube from which spurted a jet of acidulated water under steady pressure. The glass tube was connected to the diaphragm of the transmitter with an elastic envelope and the jet of water fell between two platinum plates. With a steady jet, there was constant resistance between the plates, but if the diaphragm was made to oscillate from a sound source, the resistance between the plates, controlled by the jet, was varied.

Other wireless telephoning systems have made use of the singing arc. Professor Ruhmer used a series connection of 12 arcs, each having a carbon and copper pole, the latter being kept cool by circulation of water inside. The arcs in this case were not enclosed; or under pressure. The arcs were operated at a current of four amps, at a voltage of 440 volts and the operating frequency was 400 kHz. Figure 30 shows the transmitter system used. The 12 series arcs are shown as one in the diagram. Amplitude modulation is achieved by coupling the output of a carbon granule telephone transmitter into the arc circuit via a transformer in order to modulate the current through the arc.

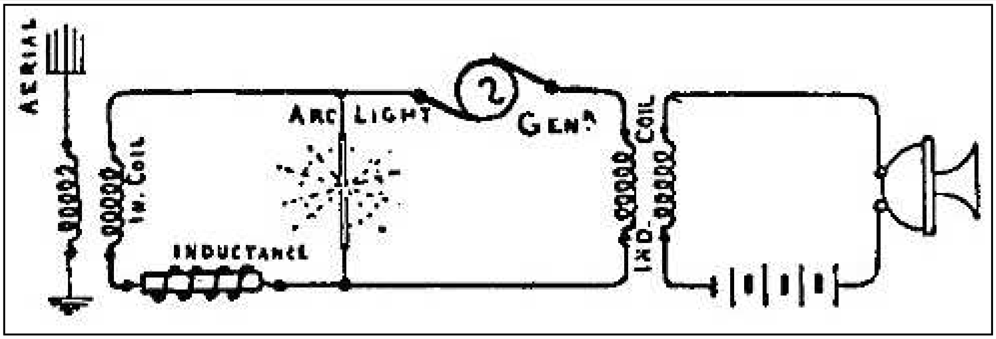


Figure 30 - Singing Arc Method of Transmission (Ref. 4)

It is difficult to understand how the low power output of a carbon transmitter or microphone could effectively modulate the high power of the arc, but it is claimed in reference four that comparatively small variations at the microphone cause very large fluctuations in the operation of the arcs. A later system used by Poulsen had 12 solid back carbon granule transmitters with electrical outputs connected in parallel and all fed from the one common voice mouth-piece.

Another modulation system for alternator type transmitters is briefly described in reference four. Effective amplification of the modulating signal is achieved by modulating the DC field current to the alternator which in turn, controls the AC output voltage.

Until the time when valve amplification methods became available, the power output of radio telephone transmitters was limited by the current control capability of the microphone transmitting devices. A single solid back carbon granule transmitter developed by Fessenden could vary the through current about half an ampere. The multiple parallel system used by Poulsen could vary it about 10-12 amperes. Where the device was used to modulate the field of a high frequency alternator, output powers from the alternator up to 1OkW were achieved. Just how well the carrier was modulated by these systems is not clear from the references.

WIRELESS TELEPHONY RECEIVERS

Professor Fessenden is accredited with a great deal of the development of early wireless telephony systems and in his experiments, he made use of a number of different detection systems. One detector utilised the liquid or electrolytic barretter shown in Figure 31. This device consists of a small cylinder containing conductive liquid, such as nitric acid. A metal diaphragm, with a small hole in the centre is immersed in the liquid, together with a finely pointed platinum wire in the centre of the hole. The diaphragm and the fine wire are connected in the detector circuit forming the non-linear element for detection, (refer Figure 32). Operation is such that the layer of liquid between the fine point and the rim of the hole forms a resistance element which varies in proportion to the intensity of the signal.

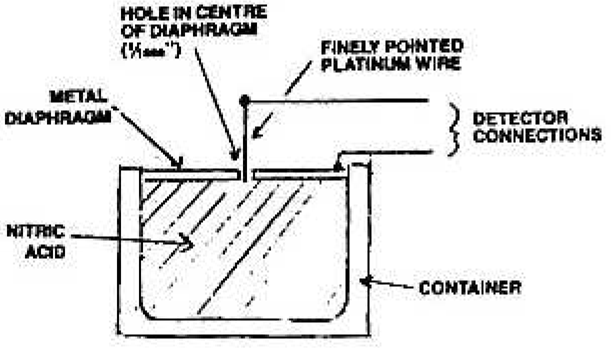


Figure 31 - Fessenden' s Electrolytic Detectors.

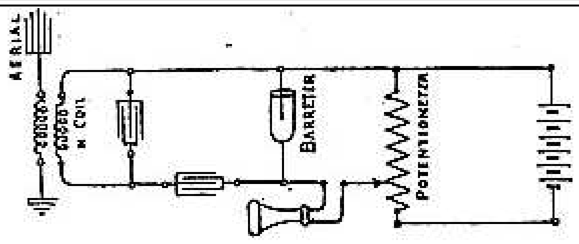


Figure 32
Barretter Receiving Circuit, Fessenden' s System (Ref. 4

The barretter is biased with a DC current from the battery which, it is assumed, allows the barretter to be set for maximum slope in the resistance versus current characteristic. According to one reference, the detector could respond to signals of 150 micro-volts.

Fessenden also made use of a thermal barretter. This was made up like an electric lamp with a very short length of platinum wire drawn to a diameter of 0.06 mil. Several of these were used in series as the non-linear element in the detection system. This utilising the principle that the resistance of the wire varied as a function of its temperature and hence the resistance varied with the strength of the signal voltage across the wire.

Fessenden was able to further improve detection sensitivity by the use of his heterodyne receiver. Heterodyning means combining two frequencies to produce a third. For example, if two frequencies of 100kHz and 98kHz are heterodyned, sum and difference frequencies are produced. If the higher frequencies are filtered out, the difference frequency of 2kHz remains.

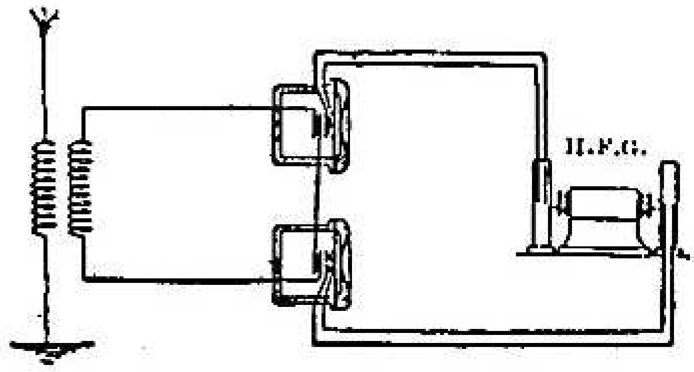


Figure 33
Fessenden' s Heterodyne Receiver (Ref. 4).

Figure 33 shows the heterodyne detector system that Fessenden used. The two telephone receivers, or headphones each have two coils around a soft iron core. One coil is coupled to the mica diaphragm and the other is fixed. One coil. is connected to the received signal source from the aerial and the other is connected to one of the outputs of the high frequency generator (HFG), set to the same frequency as the incoming carrier.

Operation of the heterodyne receiver appears to be as follows:

Due to its inertia, the diaphragm, with no modulation, does not follow the high frequency signal and, in any case, the signal could not be heard by the human ear. With modulation, sideband component frequencies are received and the summed magnetic field causing attraction and repulsion between the two coils (and moving the diaphragm), contains a component which the diaphragm can follow equal in frequency to the difference frequency of the sidebands and the high frequency generator This difference component is of course our demodulated speech or telephone signal.

Other detectors used for wireless telephony were the crystal detector and the Fleming valve detector, both previously described.

Whilst commercial wireless telegraphy became well established without the amplifier valve, early wireless telephony appeared to be mainly experimental until the introduction of the amplifier valve allowed further development of commercial voice communication and radio broadcasting.

FINALE

The era of wireless communications discussed here is barely a lifespan past. The electronics world without computers, integrated circuits, transistors and valves has been covered. At that time, the potential use of the ionosphere and the higher frequencies had still to be discovered. Old hat technology perhaps, but the foundation of an almost explosive advance in electronic technology which has now dominated our lives in almost any place we work and in our homes.

The older we get, the more we seem to enjoy researching the past. Preparation of this material has been an interesting exercise. Perhaps you have found it interesting too!

REFERENCES

1 Wireless Telegraphy - Simply Explained ... H T Davidge 1912.

2 New Harmsworth Self-Educator... Early 1900.

3 Harmsworths Wireless Encyclopedia ... 1923.

4 The Practical Telephone Handbook ... J. Poole 1912.

5 Handbook of Technical Instruction for Wireless Telegraphists ... H M Dowsett & L E Q Walker 1942.

6 Handbook of Wireless Telegraphy... H M Admiralty 1938.

7 The Historical Development of Radio Communication. J R Cox VK6NJ. Amateur Radio, December 1964 to June 1965 (continuing series)

8 From Spark to Satellite - A History of Radio Communication ... Stanley Leinwell 1979.

ACKNOWLEDGEMENTS

Many of the diagrams and photographs have been reproduced from publications in the list of references, items 1 to 6. (The source is referenced in each case within the captions below). Publication items 1 to 4 are 80 to 100 years old. However items 5 and 6 are more recent and prior approval to reproduce the relevant diagrams or photographs in "Amateur Radio" was obtained from the origin publishers "Wireless World" and "Her Majesty's Stationary Office".

Back to HomePage