

Photo 1
The Eiffel Tower as it is
today (Radio Mast on top)

The Eiffel Tower and it's Early Radio"

by Lloyd Butler VK5BR

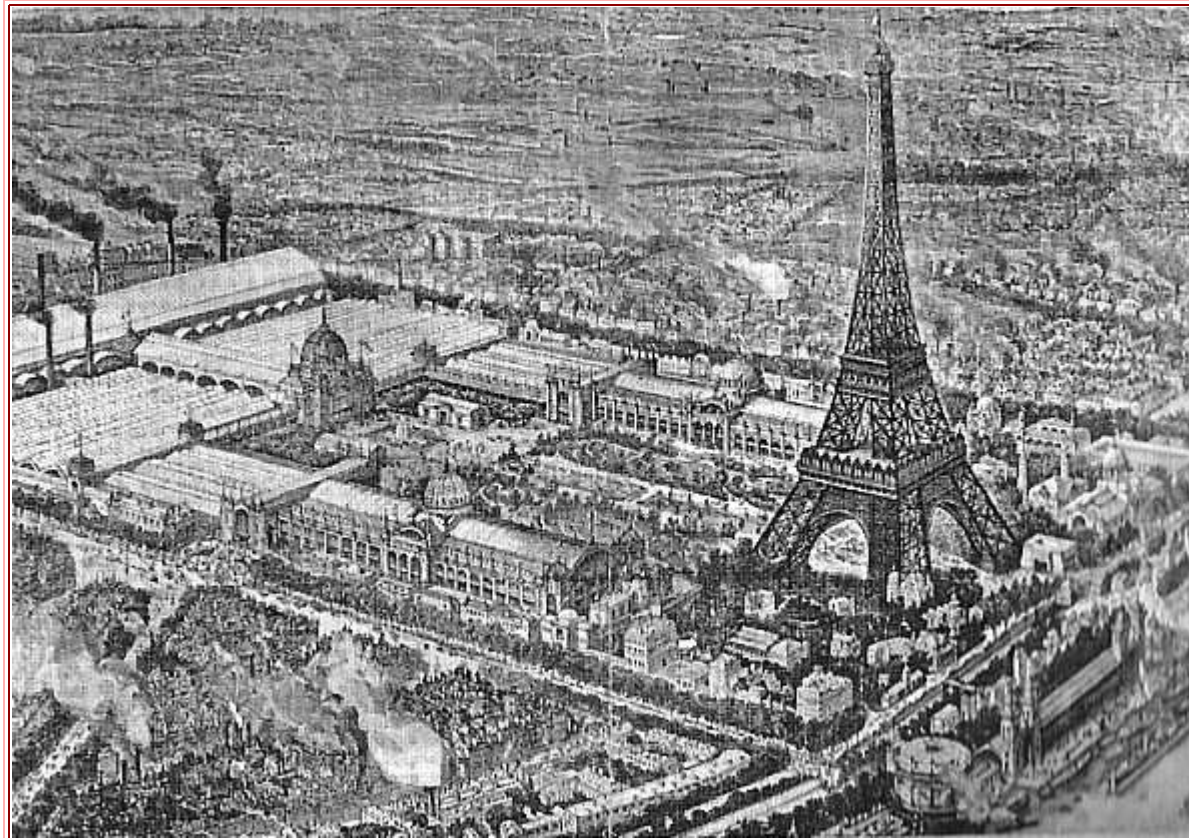
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(Some photos have since been added to the original.)

Think of Paris and you think of the Eiffel Tower which we all must visit. But it was put there as an entrance to a World Exposition in 1889. It could have been torn down but its use as a fabulous structure to support radio antennae has retained it for over 120 years. Here we look at its radio use with particular reference to the big aerial of the early years of the 1900's

Introduction

The Eiffel Tower of Paris was named after its designer, engineer Gustave Eiffel (Photo 2). The structure was built between 1887 and 1889 as an entrance arch for the Exposition Universelle, a 1889 Worlds Fair marking the Centennial Celebration of the French Revolution. It was opened on May 6, 1889.



**An 1889 print of the Paris World Exhibition building and grounds
with the newly built Eiffel Tower at the Exhibition entrance
(Photo from IEEE Antenas & Propogations Magazine Dec. 2015)**

The tower initially stood 300 metres (984 ft) tall. Built of "Pig Iron", a very pure form of structural iron, the entire tower weighed approximately 10,000 tonnes. Up until 1930, it was the tallest structure in the world. In 1957, a steel mast was added at the top for radio use (such a FM and Television) which increased the height to 324 metres (1063 ft).

My initial interest was the impressive long wave aerial system which, until around 1950, hung from the top of the tower and the LF radio transmission equipment which operated into it. My first visit to Paris and the Eiffel Tower was in 1977 and by that time the long wave aerial had been taken down. In fact I only learned about the aerial when I first did some research in the 1980s to write the article "Before Valve Amplification" (Ref. 1). I felt I had to find out some more on the Tower's radio history.

It is interesting that the Eiffel Tower was initially given an approval for its erection to last 20 years. At the end of the 20 years in 1909, the City of Paris had planned to tear it down. But it was ultimately saved because of its antenna use for Military and other communications applications. It is also interesting that during World War 2 in 1944, Hitler gave orders to his General in occupied Paris to destroy the Eiffel Tower. Fortunately, the General never carried out those orders.

Like the Sydney Harbour Bridge, the Tower has to be regularly painted to prevent rust. This is done every seven years and it takes 50 to 60 tonnes of paint.



The Early Aerial Installation

In the early 1900s, a set of aerial wires ran from the top of the Eiffel Tower to anchors on the "Avenue de Saffron" and the "Champ de Mars". The aerial wires were connected to long wave transmitters in small bunkers. However, in 1909 a permanent underground Radio Centre was built near the south pillar of the tower. The Radio Centre is still there today.

I didn't find out when the aerial wires were first installed but they remained until the 1950s. The specific date of removal has been given as 1957 but one writer claimed the long wave antenna cables were removed as early as 1946.

The aerial arrangement is illustrated in the sketch, figure 1. Observe how the individual wires are fed via taps part way up the aerial wire. I assume this is done to provide a better match for the transmitter to feed into. One might estimate that those wires are around 500 metres long but still short compared to the long wavelength used for their early spark transmitter. Connected in at the end, radiation resistance would be very low.

Photos 3 and 4 show the connection to the top of the tower. Observe the large insulators used to isolate the tower from the very high voltages. These high voltages would have developed because of the electrically shortened loaded antenna and the high power used.

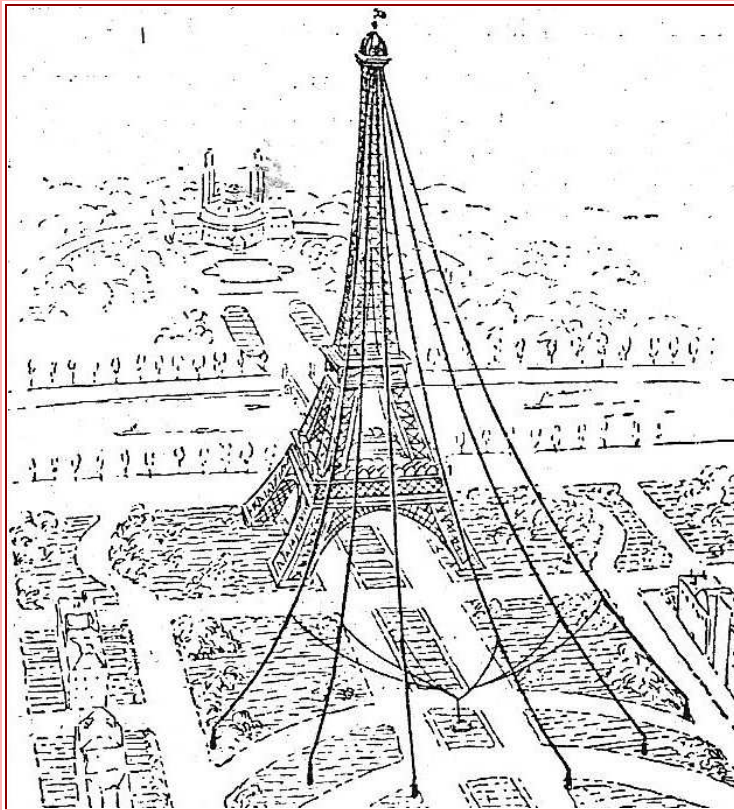


Figure 1
LF Aerial Assembly

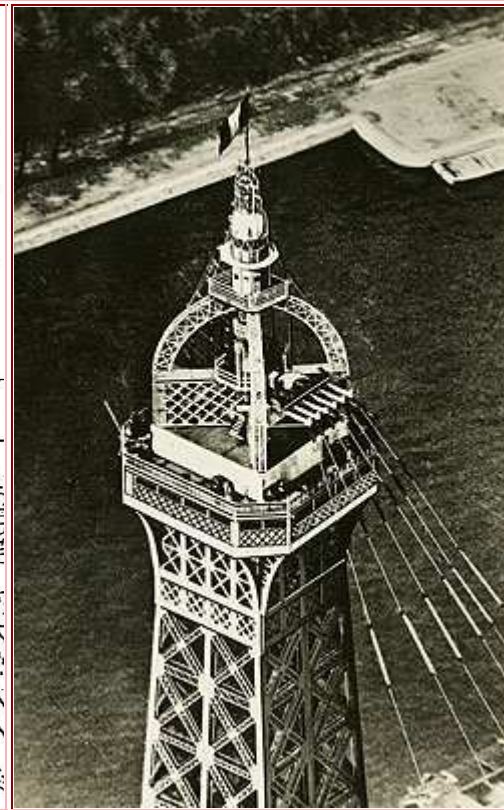


Photo 3
**Aerial cables fitted to top of
Tower**

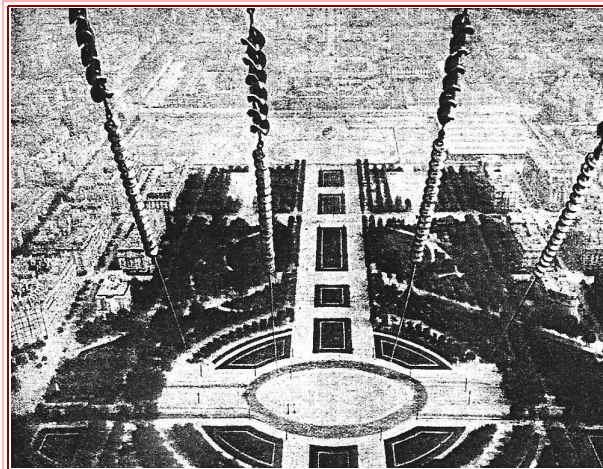


Photo 4
Insulators at top of Aerial Array

Early radio communication made use of long waves and needed large aerial systems. I guess that by the time the 1950's had arrived, radio communication and other services such as broadcasting and television had gradually moved on to shorter waves and different types of antenna systems. So I guess they no longer needed those long aerial cables and the need to maintain them. Hence, they were taken down.

Early communications



Photo 5
First Radio Contact in 1898

Gustave Eiffel was also active in developing radio communications. On November 5, 1898, he and another experimenter set up a transmitter on the third platform of the Eiffel Tower and succeeded in making the first radio contact from the tower to Pantheon four kilometres away. (See Photo 5). It would have been long waves (or LF) and I wondered what aerial he would have used. I think I would have just dropped a long wire straight down from the platform and operated against the iron structure of the tower.

Lee de Forest is recorded in history as the inventor of the three element vacuum tube or audion. He travelled to Paris in 1908 and was given permission to conduct experimental radio transmissions from the top of the Eiffel Tower. These were heard as far as Marseilles, 500 miles (800 km) away.

In 1910, radio from the tower became part of the International Time Service. From May 1910, the first regular time signal could be heard at a distance of 5200 Km. I assume that the signals were sent via the long aerial from the spark transmitter to be discussed further on.

In 1913, the Paris Observatory, using the Eiffel Tower as an antenna, exchanged wireless signals with the United States Naval Observatory in Arlington, Virginia to carry out a scientific experiment. The objective was to measure the difference in Longitude between Washington and Paris. I again assume that this was done using the Eiffel Tower long wave aerial system.

In 1914 (World War 1), the tower aerial was used for reception (as well as transmission) and played a big part in intercepting the enemy's messages. They called it the "Big Ear".

French Radio made use of the tower since 1918 and for television since 1957. The first broadcast from the tower was made by French Radio in November 1921. The first television tests were made from the tower in 1925 and the first 60 line television programme was broadcast in 1935.

The Transmitters

A little about the early transmitters was contained in one of the issues of the New Harmsworth Self Educator and written by W. W. Whiffen. Photographs included were specially obtained for the Encyclopedia by arrangement with the French Government. Unfortunately, the printed quality of these photographs is not good. I have included several of these and hope our OTN editor will be able to do something with them.

The Harmsworth publication was not dated but considering that the main transmitter was a high powered Spark unit and there were several early types of valve transmitter, I figured that the era concerned was the early 1920's.

The Spark Transmitter operated on a wavelength of 2600 metres (115 kHz). The spark transmissions were sent out mainly for the issue of time signals and meteorological observations. The time signals were sent out every morning at 10.30 am GMT. The transmitter power was not given but aerial current was quoted as around 80 amps, delivering sufficient power to be received in England on a Crystal Set.

The article discussed a little about the power sources which they had available. The spark transmitter was fed with 1000 hertz AC. To understand this, spark transmitters don't use continuous waves. They send out wave trains of damped oscillations initiated by the spark. (See figure 2). The spark initiates the charge of energy into the tuned circuit, set at the frequency of transmission and the waveform decays due to the natural oscillation and energy loss in the tuned circuit. I assume that the 1000 Hertz alternating waveform initiates the spark on its peak and breaks the spark on approach to a trough.

The tuning inductance consisted of 40 turns of brass pipe at a 3 ft (0.9 m) diameter. The tuning capacitors, mounted in oil filled tanks, consisted of flat aluminium plates with glass dielectrics and had a total capacity of 0.55 microfarads. (Referring to Photo 6, the inductor is on the left and capacitor tanks are on the right.)

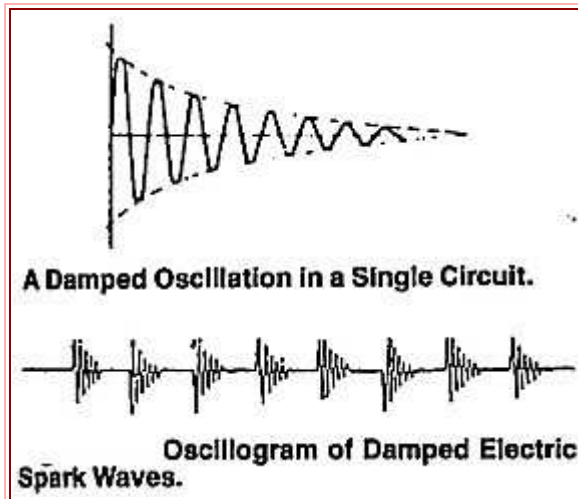


Figure 2
Damped Spark Waves

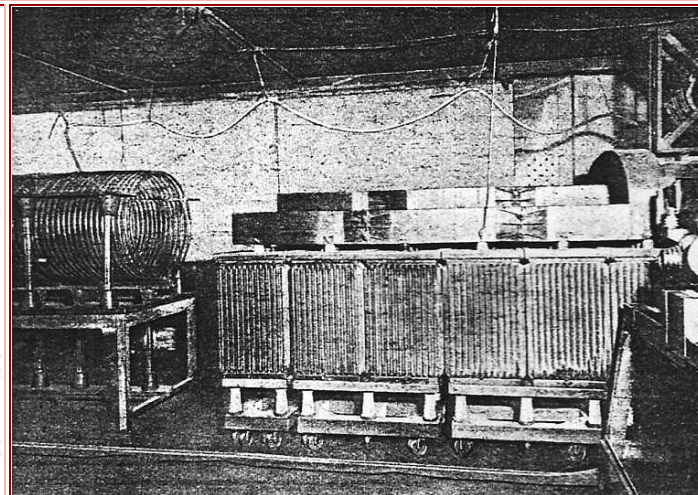


Photo 6
Tuning Inductor &
Oil Filled Tuning Capacitors

Another Eiffel Tower transmitter described in the Harmsworth Educator article, was a Poulsen Arc unit (Photo 7). which operated from 1000 volts DC and delivered a power of 60 Kilowatts. Not a lot of detail was given except that this transmitter was used during World War 1 for a Military purpose. Also a few notes were included in the caption of the photograph, Photo 7.

As distinct from the Spark transmitters, which generated damped waves, the Arc Transmitter, introduced by Valdemar Poulsen, was one of the first inventions to send continuous waves. However the characteristics of the arc were such that frequencies above 250 kHz were difficult to produce.

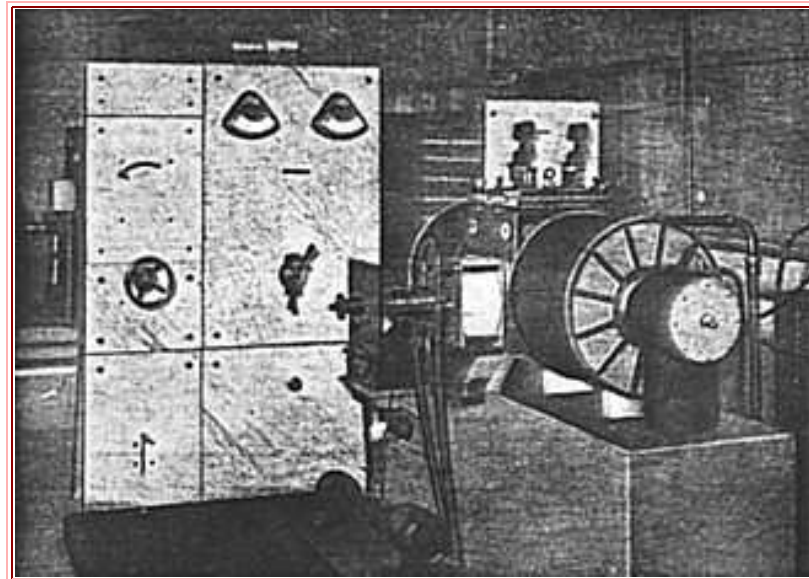


Photo 7
The Eiffel Tower Arc Transmitting Station.

**On the right is the Poulsen 60kW arc transmitter.
The powerful 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.**

Two other valve transmitters were briefly mentioned as part of the radio installation of that time:

A 1 Kilowatt transmitter using six valves apparently fed from a high frequency alternator. This was used for radio telegraphy.

A 5 Kilowatt valve AM transmitter used for Broadcasting.

Over 120 years and still an Icon

Built as feature for a World Expo in 1889 and a monument to the French Revolution, it was anticipated that the Eiffel Tower would be dismantled after 20 years. But after more than 120 years it is still there today. Once the tallest structure in the world, it is visited daily by thousands of tourists who queue up for their turn in the lifts to ascend the Tower. To the end of 2002, a total of 200 million people had visited the Eiffel Tower.

One might say that it has survived beyond the initial 20 years because it is a National monument and a great tourist attraction. But the documents I read indicate that it has also survived because of its value as a tall structure to support vital radio antennae.

The long wave aerial array is long gone but the mast at the top still supports numerous aerials for FM Broadcasting and Television on VHF and UHF.

References

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2. New Harmsworth Self-Educator... Early 1900.
3. Harmsworths Wireless Encyclopedia ... 1923.
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