Marconi and the History of Radio

In the October, 2003, issue of the *IEEE Antennas and Propagation Magazine* Bucci et. al. have published a paper on "The Work of Marconi in Microwave Communications" [O. M. Bucci, G. Pelosi, and S. Selleri, "The Work of Marconi in Microwave Communications," *IEEE Antennas and Propagation Magazine*, **45**, 5, October 2003, pp. 46-53]. This correspondence concerns Figures 3, 4, and 5 of their paper, which show (after Marconi's original paper, dated 1933) the final layout for the transmitting and receiving circuitry used for Marconi's microwave experiments.

Clearly, the circuitry shown would not function as a transmitter and a receiver. The push-pull grids of the transmitter valves are connected to the antenna and the plates are effectively shorted together by way of a shorted half-wave transmission line, connected to a low dc ground impedance (a battery). It is said that various forms of modulation methods were tried by Marconi, from the simplest method of superimposing the modulation onto the grid or onto the plate voltage, to various push-pull configurations. The choice for the experiment was said to have been plate modulation, but the modulator is not shown.

The receiver circuitry shows the plates connected to the antenna (?), and the undetected signal (no detector is shown), if there was a signal on the grids, is connected in some way (?) to the grid of an RC amplifier. It is stated that "tuning" was obtained by regulating the grid voltage, but there is no dc connection to the grids.

Marconi considered himself to be an amateur in radio, his own words. In fact, Marconi had a high regard for radio amateurs. I am a radio amateur. He considered that radio amateurs constituted a valuable asset towards further development of wireless telegraphy. Marconi was an experimenter, a demonstrator, and he spent his entire life pursuing the business side of wireless. He had the ability to adapt the inventions or ideas of others into a working wireless telegraphy system, which he then patented. His activities attracted wide media (public) attention, particularly his ship-to-shore communications systems, and, his struggles to achieve commercial transatlantic communications (radiograms), which he finally did in 1907.

However, if you read his writings you will find that sometimes he had very little knowledge about the apparatus he was using at the time (a follow-on from what I said above). I have in my files a hand-drawn sketch (see Figure 1) of circuitry for the spark-gap transmitter that I have always assumed Marconi thought he was using for his first transatlantic experiment in December, 1901. I do not remember where this sketch came from. But the circuitry sketched makes no sense. The spark gaps are shown connected across the discharge capacitors. Therefore, when the spark gaps fire, the stored potential energy in the discharge capacitors would go nowhere. The energy would be merely shorted out.

Fleming fabricated this transmitter and tuned it, and so from Fleming's sketches we know something about the circuitry used for Marconi's curious two-stage spark transmitter (see Figure 2). Note that when the principal spark gap fires, one terminal of the discharge capacitor is connected to ground through the low resistance of the gap, and the stored energy in the discharge capacitor kick-starts an oscillatory action in the "oscillator circuit" (the primary circuit of the "aerial jigger" transformer), which is then coupled to the "aerial circuit" (the secondary of this transformer). For the component values given, the resonant frequency of the oscillator circuit is approximately the same as the resonant frequency of the aerial circuit (my experimental and numerical modeling studies), viz. about 500 kHz.

I have not seen Marconi's 1933 paper (in Italian), but I suppose that the authors have translated correctly what Marconi said and showed. But surely, to aid the reader, they should have commented (in the light of today's knowledge) how they think the circuitry for Marconi's transmitter/receiver worked.

Marconi's successes, and the success of his company, are due to the very great personal commitment he put into everything he did, and the unerring judgment he displayed in choosing men of brilliance to form the team with which he surrounded himself: men

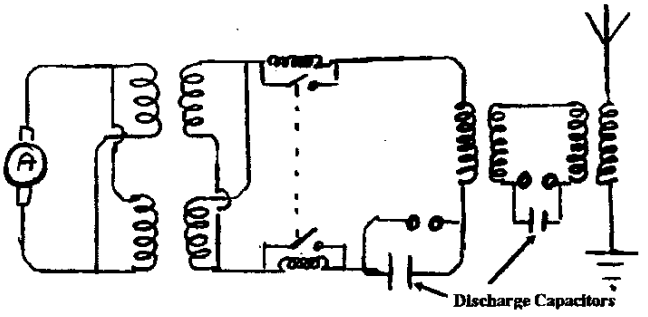

Figure 1. A hand-drawn sketch of Marconi's December, 1901, two-stage spark transmitter (after Marconi?).

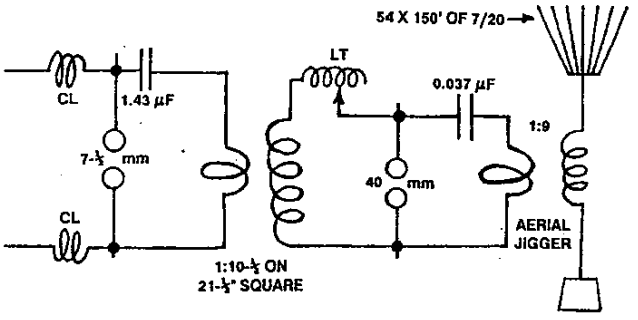

Figure 2. A schematic of Marconi's December, 1901, spark transmitter, copied from Fleming's notebook.

like Dr. W. H. Eccles, Prof. J. A. Fleming, C. S. Franklin, A. Gray, G. Isted, Dr. Erskine Murry, H. J. Round and R. N. Vyvyan – as well as many engineers of notable caliber, such as G. Kemp and P. W. Paget. I wonder who was working with him in Italy in the time period when Marconi was experimenting with microwave communications?

Continuing, the transmission distances reported (base-to-ship) for his microwave communication tests are unbelievably great: 107 km, good reception; 151 km, minimum signal; and a new maximum at 224 km! The authors say that this might have been due to ionospheric reflection – impossible for the frequency used (0.57 wavelengths) – or due to a low atmospheric duct (perhaps (?) but with the equipment used?).

...I see no mention of two principal pioneers, Canadian-born Reginald Aubrey Fessenden and Croatian (then part of the Austro-Hungarian Empire)-born Nicola Tesla (both working in the United States) on the authors' chart, "A schematic time line of the beginning of radio communications." In my view, it was Tesla's spark transmitter that made possible communication over long distances, and, while Marconi never acknowledged this, it is Tesla's circuitry that he copied, patented, and used for his long-distance transatlantic communications systems. Fessenden is the principal pioneer of radio as we know it today, and the father of AM radio broadcasting.

John S. Belrose, VE2CV
Communications Research Centre Canada
3701 Carling Avenue
Ottawa ON K2H 8S2 Canada
Tel: +1 (613) 998-2779
Fax: +1 (6130 998-4077
E-mail: john.belrose@crc.ca

Reply to "Marconi and the History of Radio"

Dr. Belrose addresses several points in his letter, and an articulated answer is well deserved.

For what concerns the layouts in Figures 3, 4, and 5, they are taken directly from the paper by Marconi cited in the references. We do agree that they are partial and schematic. There might be a reason why Marconi decided to publish those layouts as they are, but we cannot deduce what. Anyway, he provided a detailed description of the circuits. With reference to Figure 3, he said (our translation):

> The first circuit to be experimented was a Barkhausen-Gill Morell one, with Lecher threads on plate and grid....However, Lecher grid-plate circuit soon showed unsatisfactory; then, a new two tubes symmetrical circuit was developed...which led to that which was ultimately adopted, which is shown in Figure 1.

Concerning the observation on the half-wavelength transmission lines, a grounded-plate configuration can be impractical, but Marconi's text said (our translation): "The length of the conductor needed to connect the two plates is rather short...but it was found necessary to add a length of conductor of a full wave...."

Regarding the receiver, Marconi wrote (our translation):

> In the light of the results of the preliminary experiments, the circuit adopting Lecher threads between plate and grid was abandoned, and a receiver was build following the same criteria of the transmitter, i.e., with tuned plate, grid and filament circuits....Figure 5 shows the scheme of our last receiving circuit, which is presently used.

We stress that the 1933 paper to which we make reference is the faithful report of a conference held by Marconi at the Royal Institution of Great Britain on December 2, 1932, and that, as reported in our paper, the Vatican City apparatus was still in working condition in the '80s.

For what concerns the microwave experiments between Castel Gandolfo and the Elettra, the data reported are those given by Marconi in the same paper, where no evidence of the devices was given. Marconi anyway clearly stated that government representatives were onboard, witnessing the experiments, without giving names.

We do agree on the comment that Marconi was a great experimenter, demonstrator, and businessman, but we reject the suggestion that his role was merely that of someone adapting others' ideas and patenting them. Marconi was also a scientist (a Nobel laureate) and deep innovator, as many of his works demonstrate. It is true that Marconi had excellent co-workers, but their excellence should not be considered as diminishing Marconi himself; on the contrary, it shows his flare in choosing them. For what concerns microwaves, and the facts treated in the article in particular, in his 1933 paper, Marconi stated that he began to work on shorter wavelengths in 1916. At those times, C. S. Franklin was working with him. In the twenties' research, he acknowledged G. A. Mathieu and G. A. Isted for their collaboration.

The "schematic timeline" at the end of the paper was, as its title clearly states, schematic. Hence, not every single invention or discovery was in the timeline, and we're sure that many were left out. The point was to give a view of Marconi's achievements and some key milestone around him.

We are well aware of the excellent work of Nicola Tesla and Reginald Aubrey Fessenden, and even more of the excellent paper by Dr. Belrose on the latter. This paper was published in this same *Magazine* very recently (J. S. Belrose, "Reginald Aubrey Fessenden and the Birth of Wireless Telephony," *IEEE Antennas and Propagation Magazine*, **44**, 2, April 2002, pp. 38-47), and our readers are surely well aware of it, too.

The only purpose of our paper was that of enlightening, by making reference to the *original* documents, Marconi's contribution to the development of microwave communications.

O. M. Bucci
Dipartimento di Ingegneria Elettronica e delle Telecomunicazioni
Università di Napoli "Federico II"
Via Claudio 21, 80125 Napoli, Italy

G. Pelosi
S. Selleri
Dipartimento di Elettronica e Telecomunicazioni
Università degli Studi di Firenze
Via Lombroso 6/17, 50134 Firenze, Italy
E-mail: pelosi@det.unifi.it; selleri@det.unifi.it