

# The True Inventor of the Radio Communications

Igor Kuzle, *Senior Member, IEEE*, Hrvoje Pandzic, *Graduate Student Member, IEEE*, Darjan Bosnjak, *Graduate Student Member, IEEE*

**Abstract** — There are more than just a few examples in the history of innovations when it is not so obvious who exactly should be praised as the inventor of a specific device. The invention of radio communications are certainly one of them. This paper is based on historical documentation and describes the battle of Nikola Tesla and Guglielmo Marconi in the USA as well as the parallel and independent work of the Alexander Popov in the Russia. The aim of the paper is to objectively present all available historical facts and to perceive the merits of all three great inventors, as well as conditions in which they delivered their work.

**Index Terms** — Radio Communications, Nikola Tesla, Guglielmo Marconi, Alexander Popov

## I. INTRODUCTION

IT is not as trivial as it may seem at first to identify the person in history meritorious for a specific invention. This particularly applies to more recent history, from industrial revolution onwards. Often two scientists work separately on the same problem, and it can happen that the one who presents a new invention years after the other one is considered to be the inventor, only because he was in a better position for publishing his work.

Furthermore, there is the matter of national pride. One of the principles related to gas in most of the Europe is known as the Boyle-Marriott's law. On the other hand, the same principle in Great Britain is known only as the Boyle's law. Also, on the question who was the inventor of the radio, probably every Italian would answer with certainty that it was Guglielmo Marconi, because the fact is that Marconi received a Nobel Prize for that invention. The other fact is that the American Supreme Court arbitrated in Tesla's favor many years later, but this fact does not have the same severity as the Marconi's Nobel Prize. Namely, everyone knows what a Nobel Prize presents, and many would say that American Supreme court does not have any authority in Europe.

Very often in discussions on the true inventor of the radio communications the work of the Russian Scientist Alexander Popov is undeservingly forgotten.

## II. THE TESLA'S REVELATION

Like many big inventions, the invention of radio happened almost accidentally. While working with a coil in a frequency range of 500 000 Hz, Tesla had noticed that the other coil, which was laying disconnected in the other part of the room, performed some kind of light discharge, which was somehow in relation with the first coil. These coils were adjusted to the same frequency. The spark of one coil would transmit radio waves through the air and the other coil would receive these waves and transform them back to electricity. This event represented the wireless transmission of energy [1].

In the spring of 1893 Tesla presented his ideas of the wireless information transmission in Franklin's Institute in Philadelphia and to the National Electric Light association in St. Louis. Furthermore, Tesla in St. Louis presented the principle of radio communications for the first time in public. This means that already in 1893 Tesla has demonstrated the system which contained all elements of the modern radio communications: (1) an antenna, (2) grounding, (3) an electrical circuit which contains inductivity and capacity between the antenna and the grounding, (4) adjustable inductivity and capacity and (5) resonantly adjusted systems for transmitting and receiving [2]. At the first glance, everything is clear and it is obvious that Tesla was the first one to describe and realize the concept of radio. But, in the years to come the invention of the wireless communications will become the spotlight of the legal, technical and business battle, intense and abrupt not less than the battle between Tesla and Edison for the prevail of the alternating or direct current.

Wireless communications are based on theories of the two scientists who had established the bases of electromagnetism twenty years earlier. In 1873, James C. Maxwell demonstrated and revealed in practice the radiation on frequencies beside the ones of the visible light, while Heinrich Hertz acknowledged the existence of the radio waves. Additionally, Hertz accidentally made the first radio transmitter and receiver and thus showed it is possible to create an electrical signal in one place and detect it in the other. Nevertheless, it was only the evidence that electromagnetic waves exist. The radio should contain electric circuits which transmit and receive information on larger distances and this invention was still unrevealed.

### III. THE GREAT STRUGGLE BETWEEN TESLA AND MARCONI

The Italian inventor Guglielmo Marconi arrived to London in 1896 with the equipment constructed by Oliver Lodge, who managed to transmit telegraphic signs to a distance of 150 meters. Marconi added an grounding to this device, which made it identical to the one that Tesla had presented in St. Louis three years earlier. His new system enabled Marconi to send signal to a distance of 2 km and thanks to that he registered a patent in the Great Britain. After that, Marconi organized public demonstrations of his invention, and it seems that he had used Tesla's oscillator to broadcast a signal across the La Manche in 1899 [3].

Beside Lodge and Marconi, signal transmission was also in the focus of Edison's research, but he had a different approach. Edison managed to send a telegraphic signal from a moving train using a wire positioned in parallel to the telegraphic line by the railroad. This type of transmission worked only on short distances and it was marked as inefficient, so Edison gave up on this project.

Tesla filed applications for his basic radio patents in September 1897 and these patents were approved in 1900. Marconi's first patent in USA was filed on November 10th 1900, several months after the Tesla's patents were already approved. Naturally, Marconi's patent application was denied. During the next three years he continually filed new versions of patent application for radio, all of which were denied because of the already approved patents by Tesla, Lodge and the German scientist Carl F. Braun. The following comment was recorded on October 15th 1903 in the United States Patent and Trademark Office: *Most of the claims cannot be patented because of the Tesla patents number 645.576 and 649.621. The endeavors to bypass these references, along with Marconi's allegedly unawareness of the Tesla's oscillator are almost absurd. The expression „Tesla's oscillator“ is a common expression all over the world since his lecture on the alternating high frequency electric current in front of the American Institute of Electrical Engineers in 1891.* [4].

However, there was a new occurrence to turn the tide – the influence of the big corporation's monopoly. Marconi's first British company was Marconi Wireless Telegraph Company Ltd., with a branch Marconi Wireless Telegraph Company of America in the United States of America. The price of both companies' shares soon grew dramatically. The price of the shares of the British company jumped from 3 to 22 USD and young and glamorous Italian nobleman achieved the international praise. Even Edison invested in Marconi's companies and the Wall Street saluted to the merge of the old and new capital. On December 12th 1901 Marconi sent and received signals across the Atlantic Ocean for the first time [3]. After one of the engineers who were working for Tesla noticed that Marconi got ahead of Tesla, Tesla responded that the Marconi was a good man who should continue to use seventeen of Tesla's patents [3]. This statement indicates that Tesla never regarded Marconi as a serious inventor and this undervalue later proved to be a big mistake for Tesla.

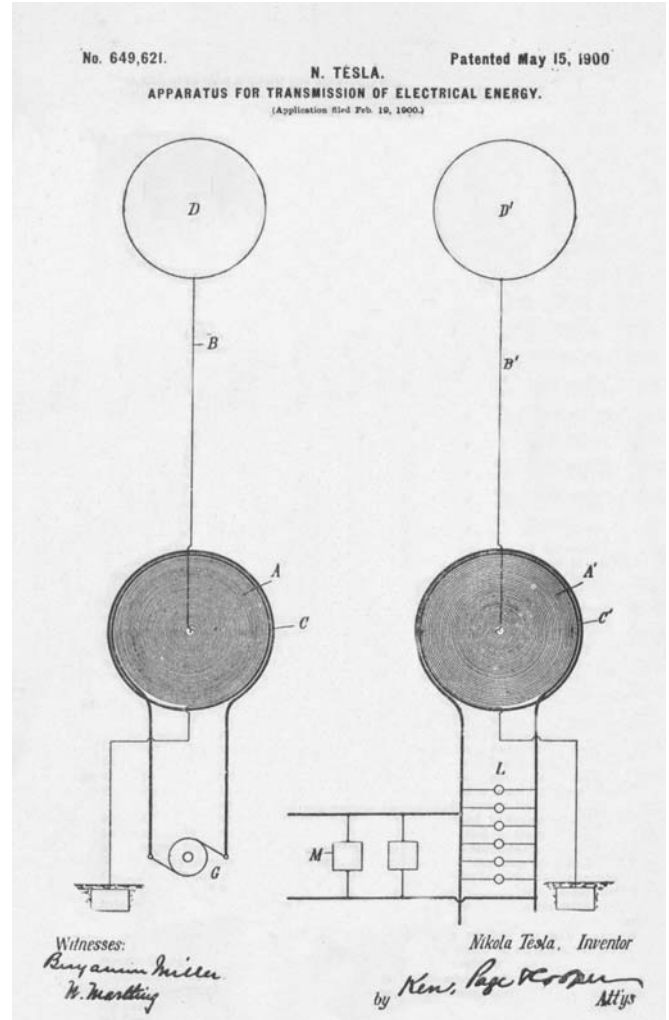


Fig. 1. The Nikola Tesla's apparatus for transmission of electrical energy patented on May 15<sup>th</sup> 1900 [5].

To everyone's surprise the United States Patent and Trademark Office changed its initial decision and in 1904 awarded the priority to Marconi's patent. Even today, the cause of that decision is not clear, but it is presumed that the successful businessmen influenced that decision. Of course, this cannot be stated with certainty. The next, even bigger injustice towards Tesla was the Nobel Prize awarded to Guglielmo Marconi in 1909. Six years later Tesla filed a suit for patent violation against Marconi's company, but his funds were insignificant compared to the big and rich Marconi Corporation and he could not afford to lose precious money and time on this trial.

Unfortunately, the satisfaction came too late for Tesla. In 1943, only few months after the death of Nikola Tesla, Marconi filed a suit against the US Army for patent violation. This resulted in the decision of the US Supreme Court that Tesla's patent number 645.576 precedes all other radio patents. Unfortunately, this acknowledgement came too late, and it is doubtful if it would have happened at all if it was not in the financial interest of the US Army. Since Tesla was already dead and did not have any descendants, the US Army did not

have to pay anything for using Tesla's patent.

Having in mind all the mentioned facts, it is possible to conclude that both Tesla and Marconi had major roles in inventing and commercializing the radio. Tesla was the inventor with a vision that describes the radio system as we use it today. On the other hand, Marconi did a great job in commercializing Tesla's invention using his charm and the business success of his companies.

#### IV. THE POPOV CONTRIBUTION TO THE DISCOVERY OF THE RADIO COMMUNICATIONS

At the same time, but in the other part of the world, Russian inventor Alexander Popov was also experimenting with the radio transmission. He entered the wireless field through his attempt to develop a device to detect thunderstorms in advance. He conceived the idea of using the Branly coherer to pick up static or atmospheric electricity - the clue to the electric storm's approach [6].

On May 7<sup>th</sup> 1895 Popov demonstrated the lightning detection apparatus to the members of the Russian Physical and Chemical Society. This apparatus was in fact the radio receiver, which contained a coherer, a primitive form of radio signal detector. While this demonstration by Popov did not involve the transmission and reception of a message, it was nonetheless a significant scientific achievement for that time.

On 1 March 12<sup>th</sup> 1896 Popov with help of his assistants Ribkin and Troytskiy demonstrated wireless transmission of Morse signals from one university building to another which was 200 meters away from the first one. This occurrence most probably represents the first regular text transmission in the world.

It is believed that on March 24<sup>th</sup> 1896 Alexander Popov also demonstrated the transmission and reception of information by wireless telegraphy at the St. Petersburg University. The occasion was another meeting of the Russian Physical and Chemical Society. Wireless telegraph signals, transmitted to a distance of almost 250 meters from another building on the campus, were audible to all in the meeting room. The President of the Society Petrushevsky stood at the blackboard holding a paper on which a listing of the letters of the alphabet and their equivalents in Morse code were written. As the signals were received, Petrushevsky referred to the paper and wrote the appropriate letter on the blackboard. The letters conveniently spelled out "HEINRICH HERTZ" - the name of a great German physicist who was the first one to demonstrate the existence of the electromagnetic waves predicted in 1864 by James Clerk Maxwell. Unfortunately, no written record of this happening was made at the time so no valid documentation was available. The existing reports of this great event are based on the recollections of several persons present at the demonstration, but were not recorded until almost thirty years later [7]. In spring of 1897 Popov conducted some experiments on the ships and was able to transmit information to a ship that was as far as 640 meters from Popov.

In the October of 1896 in Russian newspapers arose articles about experiments similar to the ones that Alexander Popov

had performed. These experiments were carried out in other countries with the goal of developing practical wireless telegraphy. Upon reading these articles, Popov was both surprised and somewhat annoyed by the way journalists were treating these foreign experiments. One of these articles reported that Mr. Marconi, from Italy, had recently come to England and had succeeded in sending telegraph signals to a distance of 2 km without wires. Alexander Popov could not understand why so much attention was being given to Marconi.

#### V. THE LEGACY OF ALEXANDER POPOV

In the process of developing his lightning discharge detector, Popov very apparently managed to send wireless signals over distances of few hundred meters as early as 1896. He incorrectly had assumed that transmitter power, rather than receiver sensitivity, was the important factor in establishing wireless telegraphy. Popov was considerably irritated when he read of the attention Marconi is enjoying for his wireless telegraphy achievements. He knew that his own earlier work was very similar to the work for which Marconi is receiving laurels. This encouraged Popov to pursue his own wireless work more vigorously and with greater persistence.

All the mentioned demonstrations produced controversy among historians concerning whether the credit for inventing the radio communications should be given to Tesla, to Marconi or perhaps to Popov.

To preserve the memory on this great event, Russia each year on May 7<sup>th</sup> celebrates the Radio Day to commemorate the achievements of Alexander Popov. Popov's achievements were also recognized by the IEEE Board of Directors and Popov's demonstration became an IEEE Milestone in Electrical and Computer Engineering.

#### VI. CONCLUSION

The purpose of this paper is to bring out all facts concerning these three great inventors. It is important to take into account all historical information and to understand the significant role of these radio communications pioneers.

Tesla and Marconi were rivals in the USA and Alexander Popov was inventing the very similar device independently.

Taking into account all the turmoil about the patents claims between Tesla and Marconi it seems that even back then all details on the true inventor of the radio communications in the USA were not clear. Therefore, the fact that Marconi received a Nobel Prize for his work does not make him a better scientist than Tesla at all. Furthermore, taking into account the work of Alexander Popov in the Russia severely complicates this subject.

To conclude, the historians of electrical engineering should not be subjective when discussing this subject and all three great inventors should be praised: Nikola Tesla for his indisputable sense for engineering and inventions, Guglielmo Marconi for his sense for commercialization of the new ideas and Alexander Popov for accomplishing his own ideas totally

independently. Tesla and Popov had very similar visions because of believing in the science for its own sake, while Marconi, as a true entrepreneur, had great ideas on turning new inventions into money.

#### REFERENCES

- [1] *And there was the Light! Nikola Tesla*, in Croatian, Z. Filipovic (editor), Zoro, Zagreb – Sarajevo, 2006, pp 59 – 62.
- [2] Quinby 1977 – The letter of E. J. Quinby addressed to Margaret Cheney
- [3] M. Cheney and R. Uth, *Tesla, Master of Lightning*, MetroBooks, New York, 1999.
- [4] L. Anderson, *Priority in the Invention of Radio*, Antique Wireless Association Review, March 1980.
- [5] *Nikola Tesla 1856-1943 Lectures, Patents, Articles*, selected and prepared by V. Popovic, R. Horvat and N. Nikolic, Nikola Tesla Museum, Meograd, 1956.
- [6] O. E. Dunlap, Jr., *Radio's 100 Men of Science*, New York: Harper & Brothers, 1944.
- [7] The Hebrew University of Jerusalem, Faculty of Science, available at: <http://chem.ch.huji.ac.il/history/popov.html>

**Igor Kuzle** (S'94-M'97-SM'04) was born in Tuzla, Bosnia and Herzegovina, in 1967. He went to primary and secondary school in Pozega, Croatia. He received his B.Sc.EE, M.Sc.EE and PhD (in the field underfrequency load shedding) degree from the Faculty of Electrical Engineering in Zagreb, in 1991, 1997 and 2002 respectively. He was awarded with faculty annual award "Josip Loncar".

Since graduation, he has been working at the Faculty of Electrical Engineering, Department of Power Systems. He is presently an Assistant Professor. He published more than 150 scientific papers and practical project studies. He has been a licensed engineer of electrical engineering since 1999. His scientific interests are problems in electric power systems control, mathematical modeling and simulation of dynamics phenomena in electric power systems (especially frequency variations).

He is the vice-chair of the IEEE Croatia Section.

E-mail: [igor.kuzle@fer.hr](mailto:igor.kuzle@fer.hr)

**Hrvoje Pandzic** (S'06) was born in Zagreb, Croatia, in 1984. He received his M.EE in 2007 at the Faculty of Electrical Engineering in Zagreb in the field of generating units maintenance in restructured power systems. He was awarded with the faculty annual award "Josip Loncar" for an excellent success during studies, as well as the "Hrvoje Pozar" award of the Energy Institute Hrvoje Pozar.

Since graduation, he has been working at the Faculty of Electrical Engineering, Department of Power Systems as a junior researcher.

He is the vice-chair of the IEEE Student Branch Zagreb.

E-mail: [hrvoje.pandzic@fer.hr](mailto:hrvoje.pandzic@fer.hr)

**Darjan Bosnjak** (S'06) was born in New York, USA in 1983. He has received his M.EE in 2007 at the University of Zagreb, Faculty of Electrical Engineering and Computing in the field of power system ancillary services.

Since graduation, he has been working at the Faculty of Electrical Engineering, Department of Power Systems as a junior researcher. His area of interests includes power system deregulation and power system voltage stability.

He is the secretary of the IEEE Student Branch Zagreb.

E-mail: [darjan.bosnjak@fer.hr](mailto:darjan.bosnjak@fer.hr)