

## SIGNIFICANT CONTRIBUTION TO THE DEVELOPMENT OF WIRELESS COMMUNICATION BY PROFESSOR ALEXANDER POPOV

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The physical and engineering foundations of wireless communications were laid by giants of science on the frontier between the 19th and 20th centuries:

James C. Maxwell (1831–1879)  
in theoretical physics  
Heinrich R. Hertz (1857–1894)  
in experimental physics  
Alexander S. Popov (1859–1906)  
in applied physics  
Guglielmo Marconi (1897–1937)  
in engineering and business

This article explains the work of Alexander Popov (Fig. 1), who was professor of physics and for a short period the director of the Electrical Engineering Institute, which is now Saint Petersburg Electrotechnical University.

This university has links with the IEEE and has a particularly good relationship with the IEEE History Committee. Figure 2 shows the IEEE Milestone tablet, which was dedicated in 2005 in the Memorial Laboratory of Professor Popov at the university. The author of this article has investigated the life and scientific activity of Alexander Popov [1–5].

Alexander Popov was born in 1859 in the village Turinskiye Rudniki (Fig. 3) in the Ural Mountains. He became interested in natural sciences early in his youth. His father ensured that Alexander received a good education at the semi-



**Figure 1.** Professor Alexander Stepanovich Popov (1859–1906).

nary in the city of Perm. He later studied physics at St. Petersburg University. After graduation in 1882 he began work as a laboratory assistant at the university.

Alexander Popov was a physicist and an electrical engineer with a wide range of interests [2–5]. His paper “Conditions of the Most Beneficial Operation of a Dynamo-Electrical Machine” was published in the authoritative Russian journal *Electrichestvo* (“Electricity”) in 1883. He took part in a scientific expedition to Siberia for observation of the solar eclipse in 1887. He studied X-rays, constructing an X-ray tube and displaying

the X-ray phenomenon before an open audience just after Roentgen’s discovery in 1895. During the summer of 1896 he worked as an electrical engineer in charge of the power plant at the Annual Fair in Nizhnii Novgorod. He was interested not only in fundamental physics, but also in different kinds of practical applications of electricity.

In 1901 Alexander Popov was appointed professor of physics of the Electrical Engineering Institute and for a short period served as the director of the Electrical Engineering Institute.

Alexander Popov took some of the earliest steps in the development of radio communications, documented as follows:

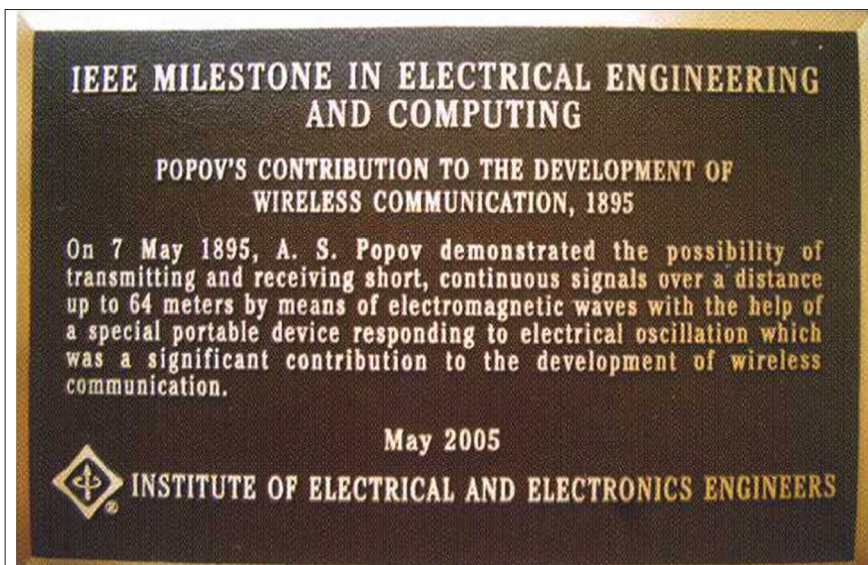
1. On 7 May 1895 he demonstrated a Hertzian wave receiver at a meeting of the Russian Physical Chemical Society (RPCS) in St. Petersburg. In March 1896 Popov demonstrated his detector to an audience of scientists from the RPCS. Although there is no published evidence that he demonstrated transmission of intelligent signals, his full paper [7] in the 1896 volume of the *Journal of the Russian Physical-Chemical Society* (JRPCS) describes both controllable sources of electromagnetic radiation used in his experiments, such as “a large Hertzian vibrator,” and the hope for future application of his apparatus in the transmission of signals over a large distance. It is not unreasonable to presume that he had already transmitted information, including at this demonstration, but was unable to say so in his paper because of military secrecy, as further described below. These papers were cited in Marconi’s patent specification.

2. An English-language letter to the editor by Popov [8] was published in *Electrician*, a British magazine.

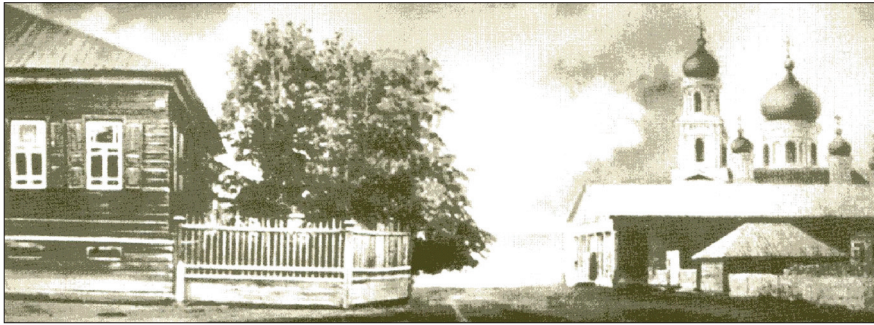
3. We will make some observations about the personal relations between Popov and Marconi.

4. There is documentation for the cooperative work of Popov with the Russian Navy. A practical application of Popov’s wireless communication system was used in January 1900 to provide an urgent communication link to a Russian cruiser, which was punctured and ran aground in the Finnish Gulf [9]. The radio communication link was established by Popov and his assistant, Pyotr Rybkin. This incident has been commemorated, as described below.

(Continued on page 22)



**Figure 2.** The IEEE Milestone tablet, displayed in the Memorial Laboratory of Professor Popov at Saint Petersburg Electrotechnical University.



**Figure 3.** The house in the village Turinskiye Rudniki where Alexander Popov spent his childhood.

(Continued from page 20)

## WHY THERE IS NO SPECIFIC MENTION OF THE TRANSMISSION OF INTELLIGENT SIGNALS IN POPOV'S PAPERS

The description of the presentation done by Popov in March 1896 in front of the audience of scientists from the RPCS was very brief and actually did not contain new scientific information. In order to explain this, one should take into account that Popov was on the staff of the Russian Navy Torpedo School in the Kronstadt naval base. The Navy Department of the Russian Empire would not permit an open publication describing transmission of intelligent signals. The officers of the Memorial Popov Museum at this university have found a document, signed by Alexander Popov in 1890, confirming that he had sworn to serve Emperor Alexander III and to maintain the secrecy of his State service [4, 5]. His service for the Russian Navy continued many years and was rather active.

## ABOUT POPOV'S LETTER TO THE EDITOR OF *THE ELECTRICIAN* (DECEMBER 10, 1897)

Popov's letter begins as follows: "Sir: The attention which you gave to the coherer in your issue of November 12 leads me to trust that you will consider my little work with this instrument described in the Journal of the Russian Physical and Chemical Society, Jan. 1896. [10; O. J. Lodge, *Electrician*, vol. 40, Nov. 12, 1897, pp. 87–91]. Thus, we can understand that Popov's letter was inspired by Lodge's letter. Popov continues: "The contents of my article were communicated to a meeting of the Physical Section of our Society in April, 1895 [6]. I translate, with abbreviation, some extracts of it."

The most important paragraph of Popov's letter to the Editor [8] is the following:

"In conclusion, I can express my hope that my apparatus (when further perfected)

will be applied for signaling on great distances by electric vibrations of high frequency, as soon as there will be invented a more powerful generator of such vibrations." This text is the exact translation of the conclusion of the paper [7] published in Russian, but the words in parentheses, which were in the Russian text, were omitted in the English-language version published in *The Electrician*. In *The Electrician* the figure showing the apparatus, which responded to electromagnetic waves, is slightly changed from the figure presented in [7]. The famous Professor Augusto Righi cited in his book [10] Popov's apparatus with the figure presented in [8].

About the omission in the English text submitted to *The Electrician*, the author of this paper would like to say that he does not know how experienced in the English language Popov was. However, in 1895–1897 Alexander Popov, as



**Figure 4.** Vladimir Vladimirovich Skobeltsyn (1863–1947). Assistant Professor of Physics Department of the Electrical Engineering Institute in St. Petersburg.

a professor of Kronstadt Torpedo School, was in good relations with Vladimir Skobeltsyn (Fig. 4), who was an assistant professor of the Physics Department of the Electrical Engineering Institute in St. Petersburg. Vladimir Skobeltsyn descended from an old aristocratic family and from early childhood had been instructed in the main European languages. He was well informed about the investigations of Popov. In April 1896 he delivered a lecture at the St. Petersburg Electrical Engineering Institute, "Apparatus by A. S. Popov for Registration of Electrical Oscillations" [11].

Certainly, Skobeltsyn could have helped Popov to correct the English of the letter to the Editor [8]. One should take into account that the letter was written, translated into English, and posted from St. Petersburg to London in a very short time interval. This circumstance suggests that the words "when further perfected" were omitted in [8] because Popov's apparatus was already adequate for application in a signaling system.

## ABOUT PERSONAL RELATIONS BETWEEN POPOV AND MARCONI

In many published materials the information about personal relations between Popov and Marconi goes back to the book *My Father Marconi* by Degna Marconi (McGraw-Hill, 1962).

There are two events described by Degna Marconi concerning Popov and Marconi:

1. The author writes about the visit of the Italian cruiser *Carlo Alberto* to Kronstadt, the Russian naval base, on July 12–21, 1902. On board the *Carlo Alberto* was Marconi's first floating wireless laboratory. On page 132 one reads: "One day a Russian caller arrived at the foot of Carlo Alberto's gangway and said to an Italian sailor who helped him aboard: 'I want to pay my respect to Marconi, the father of wireless.' That caller was Alexander Stepanovich Popoff, the Russian scientist ..."

2. The author writes about Marconi's wedding in the spring of 1905. On the page 169 one reads: "Presents poured in: silver, jewels, linens and laces, plates enough for banquets, and glasses enough for routs. Popoff sent a sealskin coat and a silver samovar from Russia."

The historical facts related to this are limited. It is known that from 1888 to 1901 Popov worked at the Kronstadt Torpedo School and lived in the town of Kronstadt. In 1901 he was elected Professor of Physics at the Electrical Engineering Institute in St. Petersburg, and

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**Figure 5.** Admiral of the Russian Navy Stepan Osipovich Makarov (1848–1904).

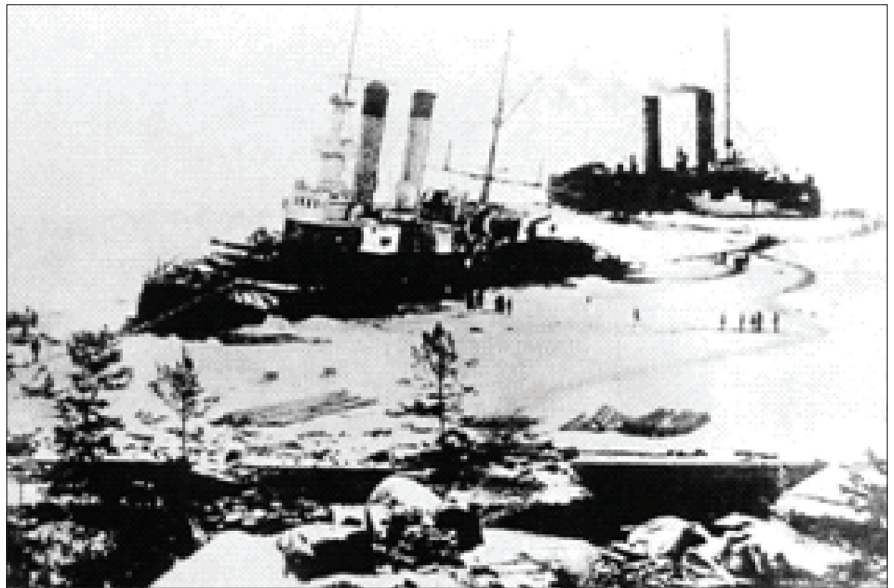
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on 25 September 1901 Popov moved to his new flat in St. Petersburg. There is no evidence that Popov visited Kronstadt in July 1902. Moreover, the Memorial Popov Museum at the Electrotechnical University is in possession of documents stating that the cruiser *Carlo Alberto* was visited by Admiral of the Russian Navy Stepan Osipovich Makarov (Fig. 5). The Admiral visited Marconi's laboratory on board the cruiser and had a conversation with Marconi about naval applications of wireless. One may suppose that somehow the two typical Russian names Makarov and Popov were confused. This may have resulted in the legend about that personal contact between Popov and Marconi.

At the same time it should be stressed that Professor Popov had a very good relationship with Admiral Makarov. The Admiral made active efforts to encourage development of wireless communications in the Russian Navy.

Being interested in the history of radio, the author of this article became acquainted with the historian Dr. Rolf Barrett who worked in Great Britain and delivered lectures on the history of radio. In 1996 Dr. Barrett wrote that he had a friendly correspondence with Degna Marconi (1908–1998). Degna Marconi was a lady of advanced years, but she was very active in correspondence with her friends.

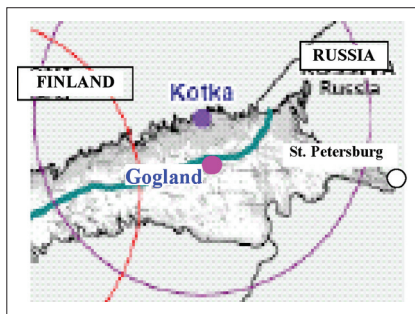
The author of this article wrote to Dr. Barrett claiming that the question about personal contacts between Popov and Marconi is a very important point in the



**Figure 6.** Armored cruiser Admiral Apraksin and icebreaker Ermak in salvage operations near Gogland Island.

history of radio and asked him to use his correspondence with Degna Marconi to investigate whether the silver samovar is still in her possession, and what kind of settlement there was concerning the samovar. The letter from Dr. Barrett was received on 21 August 1996. The letter contained the reply of Degna Marconi to the question about the samovar [3]. She wrote: “The Popov who gave the samovar and fur coat was not Popov, the scientist. It seems that this other Popov was a rich Russian industrialist, which my parents met, I am not sure where.”

In Degna Marconi's book, the paragraph about the wedding present to her father does not contain any words about Popov the scientist. The legend about friendship between Popov and Marconi seems to be an identification error.



**Figure 7.** The map of Eastern part of the Finnish Gulf marking the position of the Island Gogland and the small Finnish town of Kotka.

## COMMEMORATION OF THE ORGANIZATION BY A. POPOV OF THE RADIO COMMUNICATION LINK IN THE FINNISH GULF IN JANUARY 1900

In Fig. 6 one can see the armored cruiser *Admiral Apraksin*, which was punctured and ran aground in the Finnish Gulf. The icebreaker *Ermak* took part in salvage operations near Gogland Island. The salvage operations were complicated by the absence of communication between the cruiser in distress and the command center. In this case wireless communication became indispensable.

Figure 7 shows a piece of the map of the eastern part of the Finnish Gulf. The map helps us imagine the position of Gogland Island and the small Finnish town of Kotka, which at that time had telephone and telegraph connection with St. Petersburg, the capital of the Russian Empire. A practical application of Popov's wireless communication system was realized in January 1900 to provide an urgent communication link between Gogland Island and the town of Kotka.

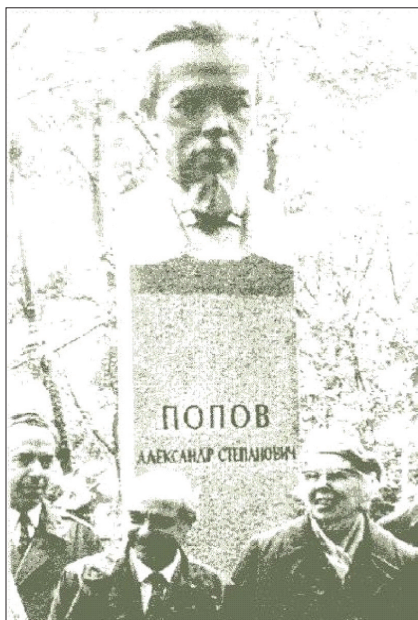
The radio communication link was established by Alexander Popov and his assistant Pyotr Rybkin over a distance of more than 30 miles. The line operated reliably for a few months under severe Russian winter conditions.

For this work Professor Popov was encouraged with a message of thanks from the Emperor of Russia Nikolai II and awarded a significant sum of money. Popov used the money for acquisition of

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**Figure 8.** Monument to one of the first practical applications of wireless communication.



**Figure 9.** Monument to Alexander Stepanovich Popov at the cemetery (photo 1972).

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an estate in the Tver' region.

In Fig. 8 one can see the monument to one of the first practical applications of wireless communication, placed in 1968 on Gogland Island in the Finish Gulf by a group of radio engineers from Leningrad.

## CONCLUSION

In conclusion, it is worth citing opinions of recognized scientists expressed dur-

ing the lifetime of Alexander Popov.

In 1903 Popov was a participant in the first International Conference on Wireless Telegraphy in Berlin. In the opening speech at the conference, the State Secretary of the Ministry of the Post of Germany, Mr. Kraetke [12], said:

*"In 1895 Popoff, in connection with his research intended to investigate perturbation of atmospheric electricity, suggested to produce telegraph signals by means of Hertzian waves: it is to him we are greatly indebted for the first apparatus recording radio signals. Marconi, with the first application of antenna as part of a transmitter, opened a new way for practical use of wireless communications. At the same time a number of highly appreciated inventors did their best to improve the new means of communications. The names of Braun, Ducretet, De Forest, Fessenden, Righi, Slaby, Arco, and Tesla are world-wide known. It is impossible to list all the names completely."*

American scientist C. H. Sewall wrote in his book *Wireless Telegraphy* [13], published in 1903: "A. Popov discovered new properties of the coherer, which opened up new possibilities of using the coherer or combination of steel needles and carbon plates as a detector in the front end of a radio receiver. Such a receiver was used in May 1900 to receive radio messages with head phones."

It should be noted that the use of a "combination of steel needles and carbon plates as a detector" describes a nonlinear element. It was the first step in the study of nonlinear electric circuits under a high frequency current, one of the starting points of modern radio physics.

The year 1905 was the year of the First Russian Revolution. The St. Petersburg Institute of Electrical Engineering could not stand aside from political events of that time. In December 1905 Professor Popov was ordered by the Governor of St. Petersburg to take repressive measures against student political disturbances. He refused, and these events severely affected his health. He died soon afterward [14].

In Fig. 9 one can see the monument to Alexander Stepanovich Popov at the cemetery. At right is his daughter Ekaterina K'yandskaya (Popova) (1899–1976). She served as the director of the Memorial Museum of A. S. Popov in the St. Petersburg Electrical Engineering Institute from the foundation of the Museum in 1948.

## ACKNOWLEDGEMENT

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