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Man, Scientist, Patriot – Mihajlo Pupin (1854 – 1935)

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This publishing year of the *Scientific Tehnical Review* is dedicated to Mihajlo Pupin. Together with Nikola Tesla and Milutin Milanković, Mihajlo Pupin is the third scientist of the Serbian origin born in 19th century whose scientific achievements in technical sciences brought him to the list of 100 most influential scientists of all time and who left his legacy to the mankind. Without his inventions in telecommunications, today's world of communications would be very hard to imagine.

MIHAJLO Pupin was born on 8th October 1854 in Idvor, a small village in the region of Banat in northern Serbia. The territory of Banat, inhabited mostly by Serbs, used to belong to the Austro-Hungarian Empire, and after WWI, the collapse of Austria-Hungary and the Treaty of Versailles in 1919, it became a part of the Kingdom of Serbs, Croats and Slovenes, later Kingdom of Yugoslavia. The friendship of Pupin and the American president Woodrow Wilson significantly influenced the rightful determination of boundaries so Idvor found itself in Yugoslavia, i.e. Serbia, and not Romania, due to the territory's history and predominant Serbian inhabitants[1,2,5].

Figure 1. Mihajlo Pupin (1854 – 1935)

Although illiterate farmers, Mihajlo Pupin's parents Konstantin and Olimpijada put their best efforts into the education of their son. Mihajlo finished primary school in his birth place as one of the best students in his generation. Led by the motto that "Knowledge is the golden ladder over which we climb to heaven", his mother persuaded her husband to let their only son continue his education, so Mihajlo enrolled in the Pančevo Grammar School, at that time one of the educational, cultural and national strongholds of Serbs in that part of Europe.

Because of his rebellious character and too openly expressed national feelings, he was expelled from school. The local Serbian church helped him to continue his schooling in Prague (Czech). When his father passed away near the end of his secondary school leaving him no funds, he embarked the Vestphalia Hamburg America Line steamship heading to New York on 12 March 1874 as a third-class passenger, with his mother blessing not to come back onto the land but to follow the path of knowledge [1,2,6].

Figure 2. Pupin's birthplace in Idvor, Serbia

He arrived at America as a penniless 20-year-old, without any knowledge of English, without finished school and without any practical skills. The first five years was an extremely difficult battle for survival. He accepted all kinds of jobs; he was a farmer, coachman, logger, factory worker, etc. When he got a steady job at a biscuit factory, he saw his chance in the factory's evening school and the Cooper Library. His goal was to prepare well for the entrance exam at the Columbia College, which he did and became a student in 1879. During his studies, he supported himself with odd jobs and not very substantial money awards for being an

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exceptional student. After graduation, his wish to continue postgraduate studies in technology prevailed over language studies and he found himself in Europe - Cambridge with a scholarship, eager to learn more about Maxwell's electromagnetic theory [1,2].

Figure 3. Portrait of Mihajlo Pupin (Paja Jovanović, National Museum, Belgrade)

His improved knowledge of mathematics and physics, with a support of Professor Tyndall, a good Faraday's friend, brought him a scholarship for the Berlin's laboratory of the then-world leading authority in experimental physics, Professor Hermann von Helmholtz. He successfully defended his doctoral thesis in physical chemistry entitled "Osmotic Pressure and its Relation to Free Energy" four years later [1,2,6].

Pupin's academic career began at a newly established Department of Electrical Engineering in the School of Mines of Columbia College, where, together with his colleague Coker, he put into practice the idea that electrical engineering, a new field of technology, can develop independently of mechanical engineering and physics. Lectures and scientific research went hand in hand. His first research papers from that period concerning electric current flow through rarefied gases helped him later to be among the first ones to produce x-rays after Roentgen's discovery [1].

Figure 4. Columbia University

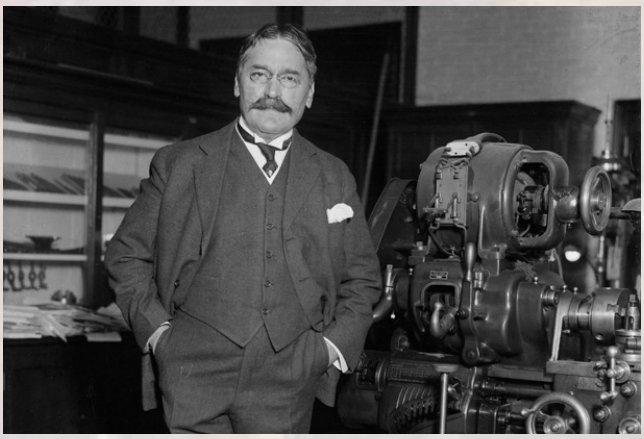


Figure 5. Mihajlo Pupin in his laboratory at Columbia University

As an expert on electricity, he was invited by the Institute of American Electrical Engineers to give a lecture on alternating currents in Boston. His lecture entitled "Practical aspect of the theory of alternating currents" was a major success which contributed to the victory of another Serb, Nikola Tesla, i.e. to the victory of the system of transmitting and distributing alternating currents over the system of direct currents, advocated by Edison [1,2,6].

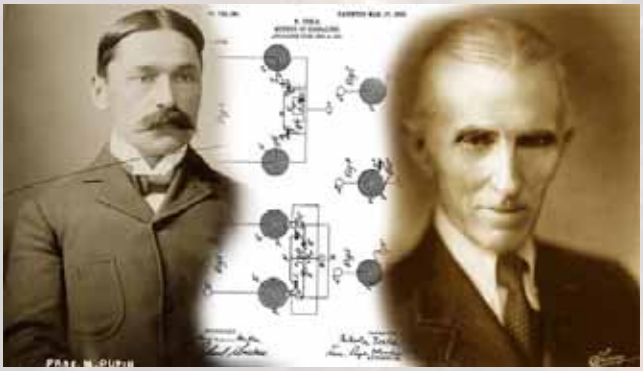


Figure 6. Mihajlo Pupin and Nikola Tesla

The first major success came in the field of the harmonics of alternating current sources. With the oscillatory circuits, resonators, he singled out particular harmonics from the complex-periodic alternating current while measuring their intensity. In some way, this is analogous to the examination of the harmonics of sound, which his mentor Hermann von Helmholtz was doing in Berlin; however, the measurement technique itself was original as well as the rest of the method. Pupin's invention of multiple telegraphy, a universal technique for the transmission of multiple signals along the same physical transmission path, the so-called frequency multiplex, is based on these works. This invention is patent protected. The technique itself is still applied, even in most modern telecommunication systems, allowing tens of thousands of telephone or television signals to be transferred along a single transmission path [3,4].

At the end of the nineteenth century, in 1895 to be precise, the world was excited by Röntgen's discovery of unknown rays that can go through paper, wood and thin metals leaving traces on a photographic plate. When he heard about the discovery, Pupin remembered his forgotten vacuum tubes from the time he had studied electricity flow through rarefied gases and used them to generate X-rays, thus becoming one of the first few in America to make X-ray photographs. His experimental results led him to the conclusion that the impact of primary X-rays generates secondary X-radiation, which gave an entirely new dimension to the discovery of these rays.

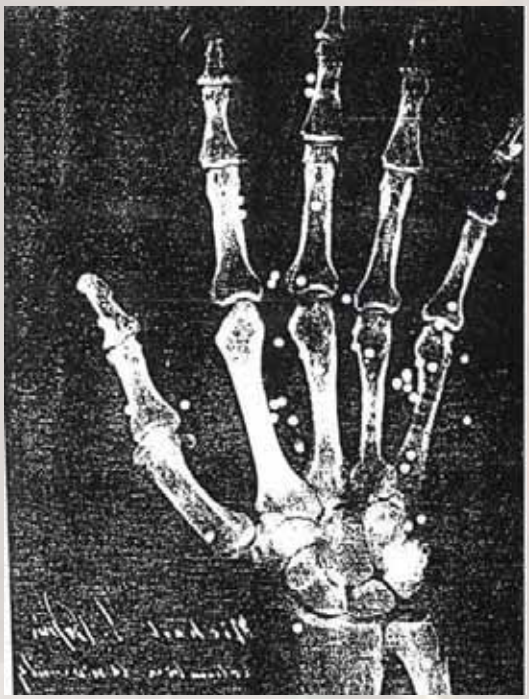


Figure 7. An x-ray photograph taken by Pupin on 2nd January 1896

Pupin's most significant invention concerns a mathematical solution to the problem of transmission of alternating currents in telephone lines. The problem with the transmission of signals lied within the capacitance per unit length. Pupin started solving this problem by first looking at a mathematical Lagrange's solution for taut wire vibration. He developed a new mathematical theory of oscillations transfer through the wire with distributed masses, which led him to the necessary dimensions of an analog electric line model with periodically inserted inductance.

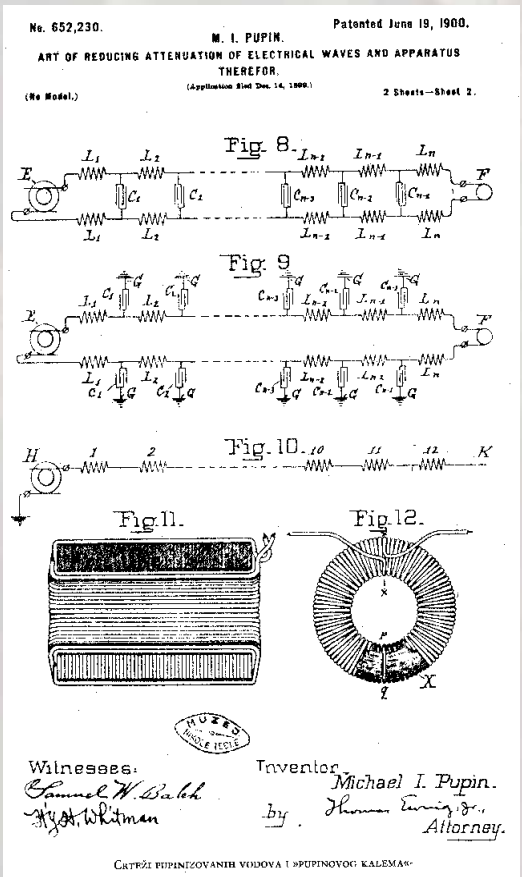


Figure 8. Sketches of Pupin's lines and the Pupin Coil

In order to verify his theory, Pupin had to build an artificial line to examine, under laboratory conditions, the propagation of telephone currents in lines. The construction of this line simulator required a lot of experimentation and calculations. The equivalent of 400 kilometers of a cable was packed into five boxes of four cubic meters. For every mile he could insert a special coil or turn it off. Without the coils, it would have been just an ordinary line, i.e. a cable. He was thus able to compare the transfer along both the loaded cable and the unloaded one and to unequivocally confirm his theory. His epoch-making discovery, patent protected, found its way to implementation very fast. Pupin's patent rights were acquired by the American Telephone and Telegraph Company (AT&T) in America and by the Siemens in Germany[1-4].

Figure 9. Patent sheet of 19th June 1900

After this discovery, the name of Mihajlo Pupin became widely known, not only in the world of science. In the period from 1884 to 1924, Pupin's 24 patents published in the United States got recognized - almost all from the field of telephony, telegraphy and radio technology. He became famous and very wealthy, but never forgot who he was, where he belonged and from where he had started off into the world [3-4].

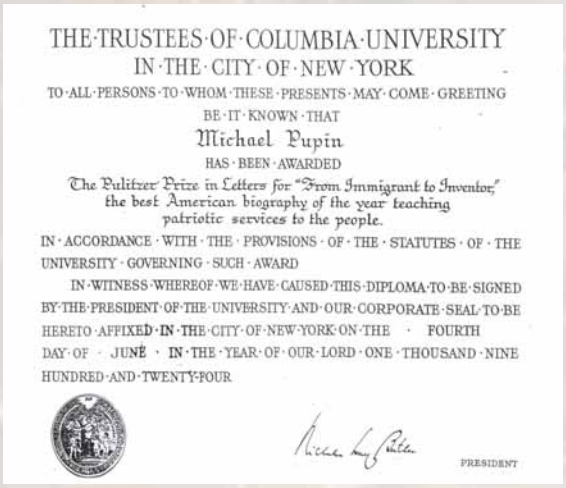
As a full professor at Columbia University, Department of Physical Mathematics and Electrical Engineering Laboratory, Pupin lectured from 1901 until he retired in 1929. Being a student of Pupin's was a remarkable privilege. Among them were a famous Nobel laureate Millikan and Edwin Armstrong, inventor of frequency modulation in radio technology, who would later say in his memoirs: " When I studied under Pupin in 1912, his discoveries in telephone technique, his systems of electrical resonance and his electrolytic detector, were known throughout the world. But what many did not know was that, in a wonderfully simple way, he was a source of inspiration to all who worked with him. We were captivated by his knowledge, human and scientific candour, richness of his linguistic

expression, by his assertiveness and trust showed towards his associates ". When another Nobel laureate, Isidor Rabi, an associate of Pupin's at the time, talked about the scientific greatness of Pupin, he said: "Even after his retirement, he continued to lecture at the University of Columbia, and when the age took its toll and his legs could not sustain him anymore and he could not move around without the wheelchair, the university made a special door for him so he would still be able to lecture and come to his lab" [6].

Figure 10. Mihajlo Pupin and Albert Einstein

Figure 11. US National Research Council (Pupin is sitting first on the right)

As a highly respected scientist, in 1915, at the height of World War I, Pupin was appointed by US President Woodrow Wilson for a member of the National Research Council, i.e. for the President of the Commission for Aeronautics, which in some way was a precursor to NASA. His direct contribution to the victory of the Allies i.e. Entente Powers, were the systems for submarine detection and systems for maintaining radio communications with aircraft in flight. After he had left the Commission in 1922, then-President Warren Harding sent him a letter publicly thanking him on behalf of the people of the USA for his work and scientific contribution to the victory in WWI [2,6].



THE TRUSTEES OF COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

TO ALL PERSONS TO WHOM THESE PRESENTS MAY COME GREETING

BE IT KNOWN THAT

Michael Pupin

HAS BEEN AWARDED

The Pulitzer Prize in Letters for "From Immigrant to Inventor," the best American biography of the year teaching patriotic services to the people.

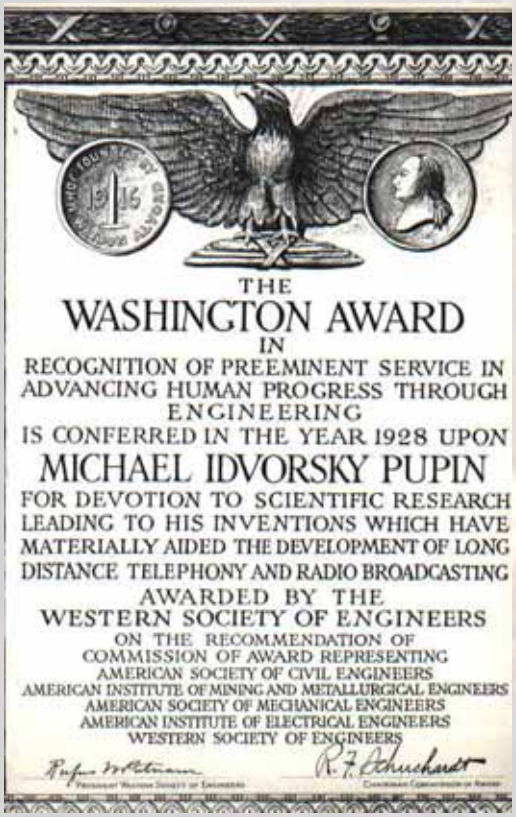
IN ACCORDANCE WITH THE PROVISIONS OF THE STATUTES OF THE UNIVERSITY GOVERNING SUCH AWARD

IN WITNESS WHEREOF WE HAVE CAUSED THIS DIPLOMA TO BE SIGNED BY THE PRESIDENT OF THE UNIVERSITY AND OUR CORPORATE SEAL TO BE HERETO AFFIXED IN THE CITY OF NEW YORK ON THE FOURTH DAY OF JUNE IN THE YEAR OF OUR LORD ONE THOUSAND NINE HUNDRED AND TWENTY-FOUR

PRESIDENT

Figure 12. Pulitzer Prize for the book "From immigration to inventor'

Mihajlo Pupin was an extremely prolific writer. In addition to scientific papers and books in the field of science, he also wrote fiction. For his autobiography published in 1923, entitled "From Immigrant to Inventor" and dedicated to his mother Olimpijada, he won the Pulitzer Prize, the largest literary award in the US. By a White House decision, the book was made compulsory reading in schools, colleges and the US Army because of its content, great style, message and its ethical and educational values. He also published a book on the monuments of the South Slavs in 1919. This book introduced the world public to the South Slavs that had just formed their common state which would become known as Yugoslavia [1,2,6].



THE
WASHINGTON AWARD
IN
RECOGNITION OF PREEMINENT SERVICE IN ADVANCING HUMAN PROGRESS THROUGH ENGINEERING
IS CONFERRED IN THE YEAR 1928 UPON
MICHAEL IDVORSKY PUPIN
FOR DEVOTION TO SCIENTIFIC RESEARCH LEADING TO HIS INVENTIONS WHICH HAVE MATERIALLY AIDED THE DEVELOPMENT OF LONG DISTANCE TELEPHONY AND RADIO BROADCASTING
AWARDED BY THE
WESTERN SOCIETY OF ENGINEERS
ON THE RECOMMENDATION OF
COMMISSION OF AWARD REPRESENTING
AMERICAN SOCIETY OF CIVIL ENGINEERS
AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS
AMERICAN SOCIETY OF MECHANICAL ENGINEERS
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
WESTERN SOCIETY OF ENGINEERS

Figure 13. Recognition for Pupin's contribution to science

In addition to being a great scientist, Pupin was a great humanist, patriot and skillful politician. In a very critical moment after WWI when the borders of the Kingdom of

Serbs, Croats and Slovenes, i.e. future Yugoslavia, were in the process of shaping, on 19 April 1919, Pupin sent a memorandum to the President of the United States exposing essential facts upon which three days later US President Woodrow Wilson issued a statement of the non-recognition of the Treaty of London formed by Allies with Italy and Romania by which entire areas where South Slavs of different faiths lived were supposed to be given to Italy and Romania as a part of the bargain for their help in the war. Thus Yugoslavia got Bled with its surroundings (Slovenia), parts of Dalmatia, Medjumurje and Baranja (Croatia) and a part of Banat (Serbia) [5].

Figure 14. Mihajlo Pupin Institute, Belgrade, Serbia

Serbia and the United States has had diplomatic relations since 1882, and Pupin was the first Honorary Consul of Serbia in the United States. He held that position from 1912 to 1920.

A world-renowned institute in the field of electronics and telecommunications in Belgrade, Serbia, is named after him, and an amphitheater at Columbia University bears his name.

During his lifetime, Mihajlo Pupin was an honorary professor at twenty universities around the world. He was a member of the US National Academy of Sciences, the French Academy of Sciences, the Serbian Academy of Sciences, and was the first president of the New York Academy of Sciences born outside the territory of the United States [6].

One could say no more about a man who was a friend with the science's greats like Albert Einstein and Nikola Tesla, except that he was one of them, one of the scientific titans of the world.

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Čovek, naučnik, rodoljub, Mihajlo Pupin (1854. – 1935.)

Ova izdavačka godina časopisa Scientific Tehnical Review posvećena je Mihajlu Pupinu. Uz Nikolu Teslu i Milutina Milankovića, Mihailo Pupin je treći naučnik srpskog porekla rođenih u XIX veku, koji je svojim naučnim dostignućima iz oblasti tehničkih nauka zadužio svet i tako dospeo na listu od 100 najznačajnijih naučnika čija otkrića baštini celo čovečanstvo. Bez njegovih otkrića u oblasti elekomunikacija pitanje je na šta bi ličio današnji svet komunikacija.

Человек, учёный, патриот – Михайло Пупин (1854 – 1935 гг.)

В этом издательском году журнал Научный Технический Обзор посвящён Михайлу Пупину. С Николой Тесла и Милютином Миланковичем, Михайло Пупин является третьим сербским учёным рождёным в XIX веке, чьи научные достижения в области технических наук представляют долг мира к этому учёному, и таким образом его имя находится среди 100 самых крупных учёных, чьи открытия являются наследией всего человечества. Без его открытий в области телекоммуникаций, возникает вопрос, каким бы выглядел современный мир коммуникаций.

Homme, savant, patriote, Mihajlo Pupin (1854.- 1935.)

Cette année l'édition de Scientific Technical Review sera dédiée à Mihajlo Pupin. Avec Nikola Tesla et Milutin Milanković, Mihajlo Pupin est le troisième savant d'origine serbe né au 19ième siècle qui est connu mondialement pour ses découvertes dans le domaine des sciences techniques. Pour cette raison il se trouve sur la liste des 100 savants les plus importants dont les inventions représentent l'héritage de l'humanité toute entière. On se demande à quoi ressemblerait le monde moderne des communications sans les découvertes de Mihajlo Pupin dans les télécommunications.